TECHNICAL REPORT NO. 3

CHEMICAL CHARACTERISTICS OF SANTA FE RIVER IN RELATION TO LOCAL GEOLOGY

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INTRODUCTION

The Santa Fe River, from its origin at Santa Fe in northeast Alachua County, to its confluence with the Suwannee River 72 miles downstream, is one of the most diverse systems in the country. It flows through swamp forests up to 100 yards wide and thick hammocks in high areas characterizing two distinct physiographic regions. The river flows in a generally northwest direction for 64.4 km (40 miles) to O'leno State Park where it flows underground for 3.2 km and from its rise, continues westward for 48.3 km (30 miles).

Sixteen springs are actively flowing into the river between US Hwy 441 and the Suwannee River. The area is relatively unspoiled with most of the housing occurring between SR 47 and the Ichetucknee River. The Santa Fe River Basin is important not only in geological terms but as a popular recreational area. With the extremely rapid growth west of Gainesville it is important that the value of this area be understood.

The Santa Fe River system contains more than forty fish species and about fifty invertebrate species. Two species which are of special interest are the Suwannee Bass, *Micropterus notius* and the spotted bullhead, *Ictalurus serracanthus*, both endemic to the Suwannee, Santa Fe and Ochlocknee Rivers. Bass and Hitt (1973) have postulated that the high concentration of Micropterus is due to excellent water quality and general environmental stability in the lower Santa Fe. Many species of birds, including eagles, great blue herons, ibises, pileated woodpeckers and red-shouldered hawks inhabit cypress trees and shrubbery along the river banks. Otters and alligators can be seen in the shallow areas of the river.

Alterations of the river could cause a reduction in water quality and species diversity and result in a decrease in stability of the entire ecosystem.

Records of water quality and stream discharge are incomplete. Of 200 stations sampled over a 25 year period, only 17 stations were found to have usable data (Schomer and Hand, 1980). The present survey was designed to measure water chemistry along the course of the river and to establish baseline data for use in future studies.

DESCRIPTION OF STUDY AREA

Location

The headwaters of the Santa Fe River form at Santa Fe Lake (T9S, R22E) in N.E. Alachua County, FL. The river flows in a generally westerly direction to the Suwannee River two miles south of SR 127 between Gilchrist and Suwannee Counties (T7S, R14E). The location of all study sites is shown in Figure 1.

Climate

General climatic conditions are warm temperate with a mean annual temperature of 69° F. Summer temperatures can exceed 100° F, however thundershowers can lower temperatures as much as 30 degrees in a short period of time. Rainfall normally fluctuates about a mean of 51.8 inches a year (Buston, 1962). The rate of evapotranspiration is 39.7 inches and the average annual precipitation available for runoff is 12 inches.

The river responds quickly to changes in rainfall and the floodplain normally reaches water depths of over eight feet at least once in every three years (Schomer and Hand,1980). At present the water table is at

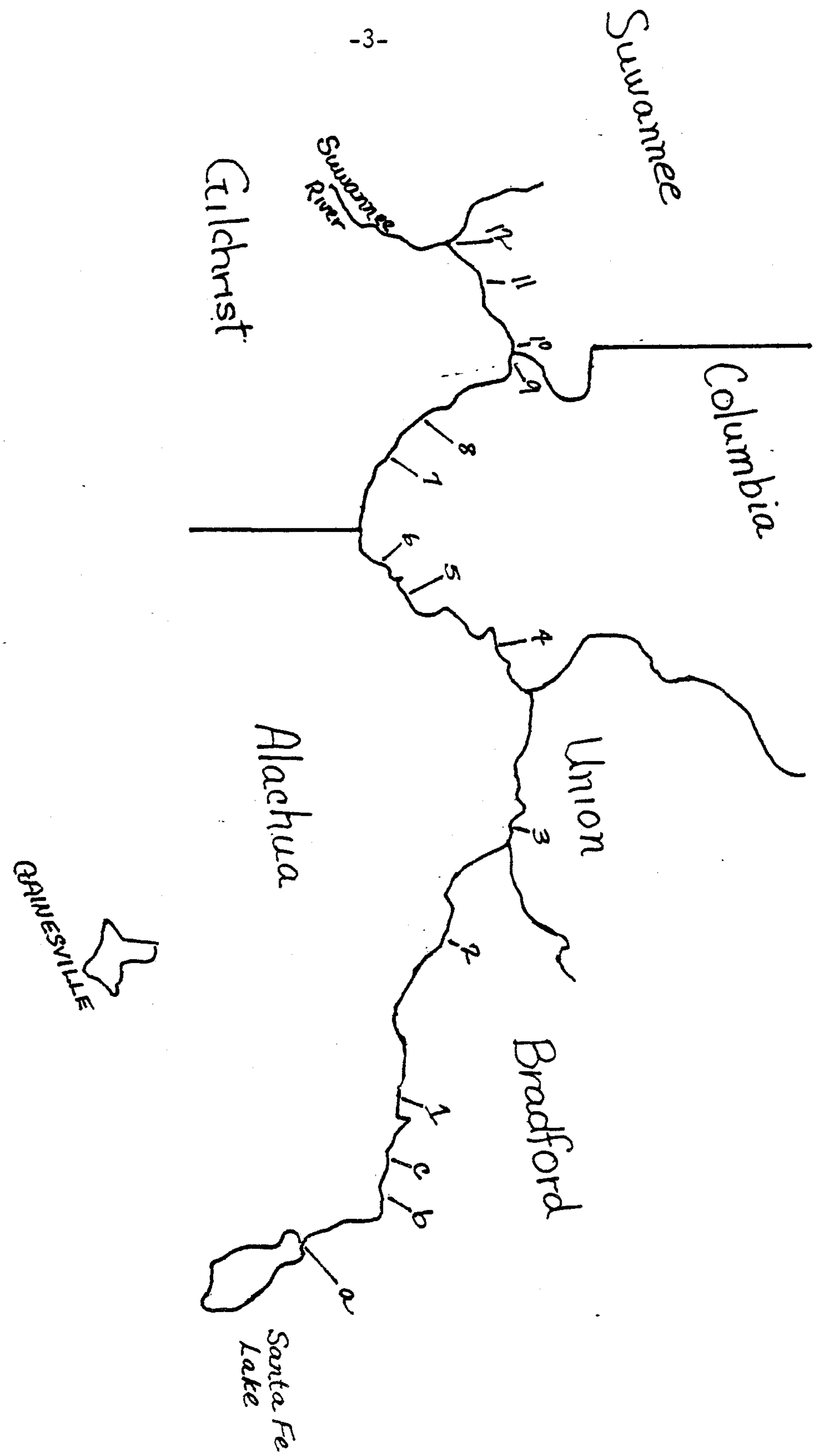

Figure 1. Site Locations.

Stations are listed as they appear downstream from Santa Fe Lake. Counties bordering on the river are also listed. Appendix B gives a detailed description of site locations.

its lowest level in 50 years and Florida aquifer levels are 2-3 feet below the September average (St. Johns Water Management District, Sept. 22 Florida Alligator Rpt.). The average rainfall for the last three years, however, was 59.3 inches per year for the High Springs area (Mitchell, 1979-1981).

GEOLOGY

The Florida peninsula is divided into three trans-peninsular zones, the boundaries being oriented perpendicularly to the length of the state. (Figure 2). The northern zone extends from Georgia to a line passing through St. Augustine, Palatka, Hawthorne and Gainesville and just south of High Springs. It is distinguished by high ground forming a broad upland extending across Alachua County to a lowland called the Eastern Valley. The ground surface of the northern zone lies above the piezometric surface of the artesian waters of Florida and is characterized by dry highlands with dry sinkholes, springheads and beds of former lakes. These northern Highlands are limited on the south and east by an outfacing scarp which extends through the East Gulf and Atlantic Coastal Plains (Dolan, 1961). This scarp is the most persistent topographic break in the state.

East of Gainesville, along the eastern bounding scarp, all streams maintain continuous surface discharge as they cross the scarp. A capping by clays of the Hawthorne Formation occurs to the east and soluble limestone is exposed to the west. These clays have confined artesian flow sufficiently to maintain a piezometric surface generally higher than the ground surface in the stream valleys and have assured surface drainage in these valleys. West of Gainesville there is no such pressure and the piezometric surface is lower than the valley floors in the steeper sloping scarp zone. This allows streams to flow underground into the limestone

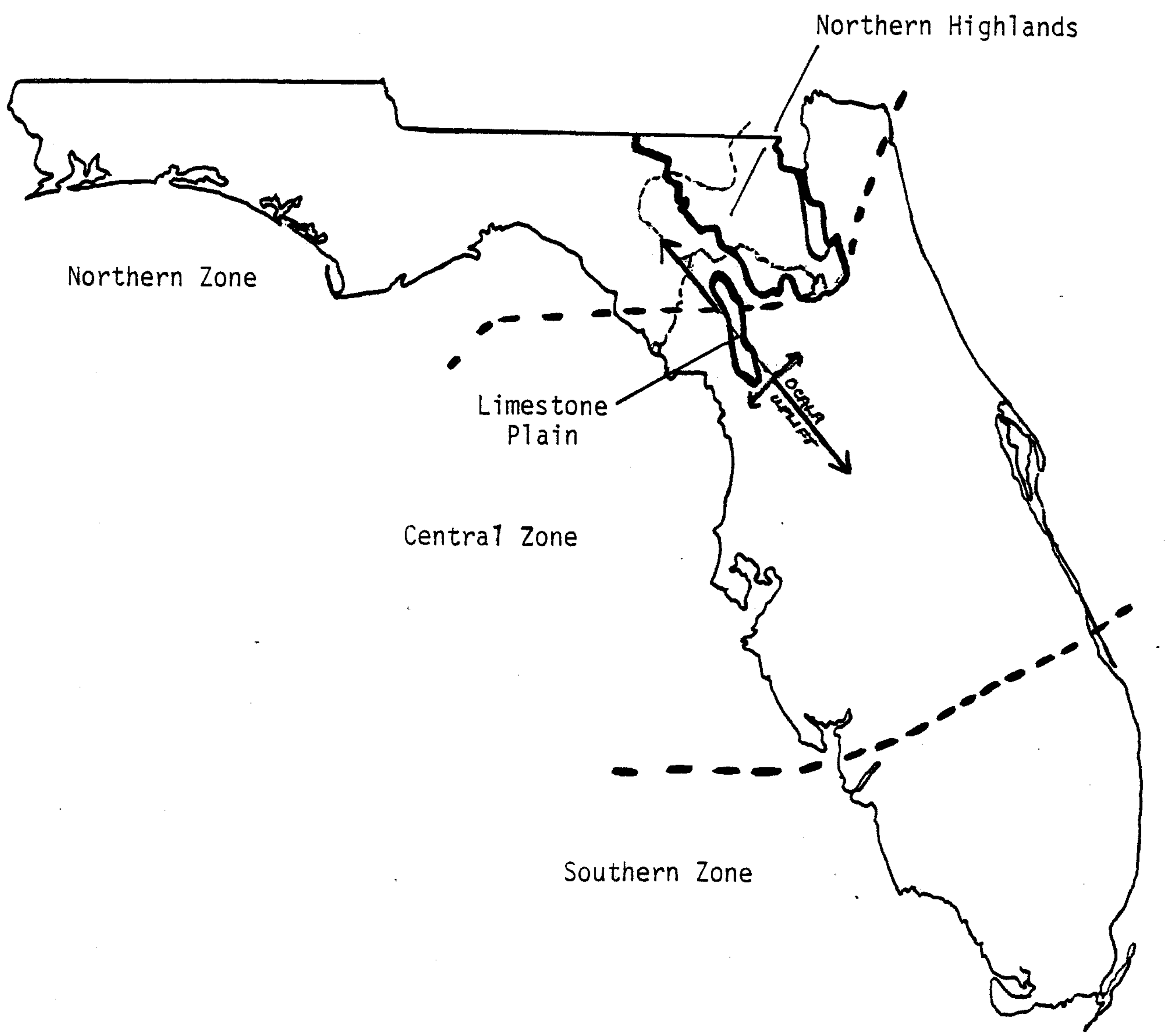

Figure 2. Physiographic map of North Central Florida modified from White (1970). Santa Fe River appears as a dotted line merging with the Suwannee River.

(White,1970). With the exception of the Suwannee River, every stream that enters the scarp zone goes underground and re-emerges while crossing the scarp zone (Sierra Club, 1972).

The headwaters at Santa Fe lake lie within the Northern Highlands. Here, surface stream are common with Sampson River, New River, Swift Creek and Olustee Creek forming a tributary system for the Santa Fe River. Precipitation infiltrates the loose surface sands and discharges into swampy depressions and surface streams.

From its rise south of O'leno State Park to its confluence with the Suwannee River, the Santa Fe receives no flow from tributary surface streams. Approximately 517 million gallons/day are added to the river from the Florida aquifer through karst limestone formations. These karst formations are controlled by a fracture system of faults representing tectonic adjustments parallel to the Ocala Arch, with the axis of the fold passing through this area. This zone of uplift exposed the Eocene limestones to rainwater containing dilute carbonic acid which started the solution process. With advances of the sea, the overlying sediments continued to erode away and upper surface of limestone and subsequent withdrawals of the sea allowed continuing solutions of the limestone. At present the rate of solution is approximately 172 tons/m^2/year (Brooks, 1967).

Large solution channels are required for the entire river to go underground at O'leno and to discharge through a series of rises downstream. The discharge volume here is 1.3 times that entering at O'leno sink (Sierra Club, 1972).

The transition zone between the Northern Highlands and the limestone plain is an area in which a large volume of runoff from the highlands is discharged onto the limestone in sinks, lake basins, and prairies. In some areas, there is an abrupt erosional scarp, but in most areas there is a belt 4-10 miles wide dissected by sinkholes and caverns. The erosion rate here is 262 tons/m^2/year, whereas in the highland areas the rate is insignificant (Brooks, 1972).

The limestone plain lies west and southwest of Gainesville at an elevation of 90-100 ft above sea level and drops 1 ft/mile at its boundaries. Here, the Floridan aquifer is over 500 feet deep. Much of the solution of the limestone occurs here under hydrostatic (artesian) pressure.

The area south of O'leno satisfies all four conditions for maximum development of karst. First, soluble rock should lie near the land surface. Second, the soluble rock should be dense, highly jointed and thin-bedded. Third, valleys should exist below higher land surfaces which are underlain by soluble and well-jointed rocks. The Santa Fe River is presently cutting into limestones of the Floridan aquifer, resulting in discharge of water from the aquifer to the river. Because of the gradient in the water table due to discharge through the springs, groundwater flows to this area from as far away as Gainesville (Sierra Club, 1972). Prairie Creek which flows into Paynes Prairie at Alachua Sink and Hogtown Creek flow over 20 miles to the point of nearest discharge from the aquifer (Brooks, 1975). Rose Creek, which disappears at Columbia City and a longer stream flowing into it at Bass (3 miles north of Columbia City) both feed into the Ichetucknee river through underground passages. This moving water dissolves limestone, whereas standing water does not. The fourth condition (which this area satisfies) is adequate amounts of rainfall.

LAND USE

Schomer and Hand (1980) divided the Santa Fe River into six subsegments (Figure 3) with seven land use categories (Table 1). They found that at least half of the land adjacent to the Santa Fe is forested. North of where the New River meets the Santa Fe just north of SR 121 almost 20% is classified as a wetlands area, whereas south of this point wetlands comprise from 3-7% of the total area. Less than 25% of the land segment north of the New River is being used for agricultural purposes, whereas over 40% south of this point is tied up in agriculture. Schomer reported that no land is being used as rangeland, however cattle were observed both in upper and lower stretches of the river during this study.

A maximum of 5% of the land in the subsegments are classified as urban areas and is reflected mainly in homes built on the banks of the river. At several locations adjacent to homesties, dredging of wetland areas had recently occurred. The resulting erosion of banks denuded of cypress trees and other vegetation could increase sedimentation while fertilizers and construction debris could contribute to nutrient loading into the river.

METHODS

A. Sampling Methods

Surface water (0.5 m) samples were collected biweekly at each site from May 25, 1981 to Sept. 15 by boat, wading or using a rubber raft. Sites were chosen by ease of access and apparent physical variation between stations. Water samples were collected in acid-washed nalgene bottles, packed in ice and returned to the laboratory for analysis.

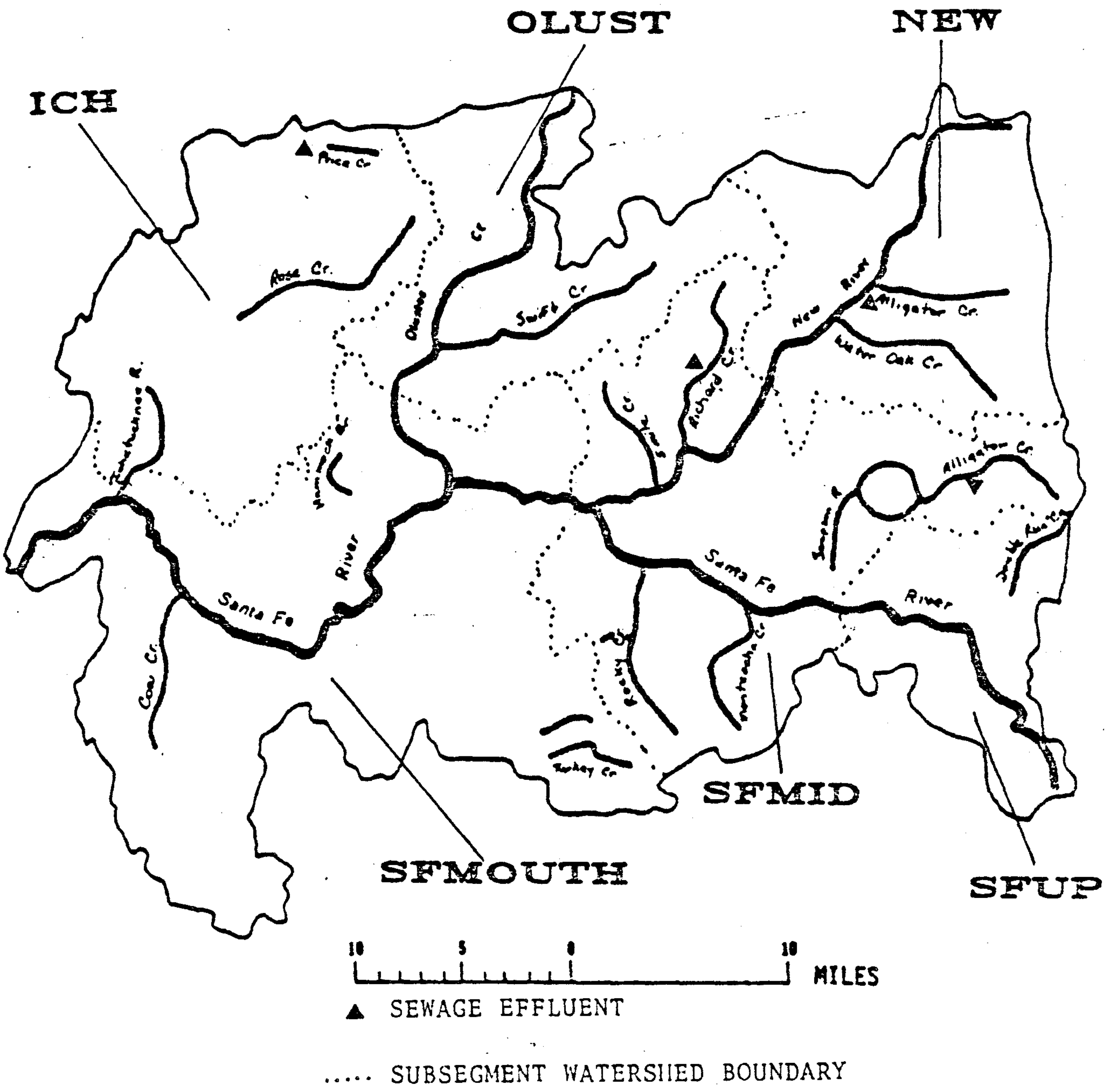

Figure 3. Santa Fe River Basin subsegments taken from Schomer and Hand (1980). The six subsegemnts separated by the dotted lines are: SFUP = Santa Fe Lake to near Brooker; SFMID = the mid section downstream of Brooker to O'leno State Park; NEW = the New River segment; OLUST = the segment in which Olustee and Swift creeks join; ICH = the segment of the river with Ichetucknee River; SMOUTH = the segment of the river from O'leno down to the Suwannee River.

Table 1. Land use acreages in the six Santa Fe subsegments taken from Schomer and Hand (1980). The six subsegments are: SFUP = Santa Fe Lake to near Brooker; SFMID = the middle section downstream of Brooker to O'leno State Park; NEW = the segment of the Santa Fe containing the New River, one of the Santa Fe's tributary streams; OLUST = the segment in which Olustee Creek and Swift Creek join; ICH = the segment of the river containing the Ichetucknee River; SMOUTH = the segment of the river from O'leno State Park to the Suwannee. Land use numbers = percent of total acreage.

	Subsegment					
	SFUP	NEW	SFMID	OLUST	ICH	SFMOUTH
Urban	3	2	2	1	5	2
Agriculture	12	17	24	9	42	41
Range	0	0	0	0	0	0
Forest	54	63	60	77	48	50
Water	11	0	2	1	0	0
Wetland	19	18	10	13	3	7
Barren	1	1	1	0	2	1
Total Area (Ha x 10^3)	24.6	49.1	74.7	42.9	55.1	104.5

B. Physical Measurements

Streamflow was calculated at each site using a Marsh-McBriney Model 201 protable water current meter. Depth and flow measurements were averaged from three points across the stream and multiplied by the width to get total stream discharges.

Dissolved oxygen and temperature was measured using a Yellow Springs Instruments Company Model 51A oxygen-temperature meter. Water clarity at each site was measured using a 20 cm black and white secchi disc.

C. Chemical Measurements

Specific conductance was measured using a Yellow Springs Instrument Company Model 31 conductivity bridge. An Orion Model 601A pH meter was used for pH measurements. Total and phenol alkalinity was determined by titration with 0.02 N sulfuric acid (APHA, 1976). An Orion 601A pH meter and bromcresol green-methyl red indicator was used in determining the endpoint. Total phosphorus concentrations were determined by the procedures used by Murphy and Riley (1962) with a persulfate digestion (Menzel and Corwin,1965). Total nitrogen was determined by using a modified Kjeldalh technique (Nelson and Sommers 1975). Total and calcium hardness concentrations were determined by titration with Hexaver chelating reagent (Hach Chem. Co.,1975). ManVer hardness indicator and CadVer calcium indicator (Hach Chemical Company 1975) were used for endpoint determination.

Water was filtered through a Gelman type A-E glass filter for color determination using the platinum-cobalt method with Nessler tubes (APHA 1976).

D. Biological Measurements

The concentration of plankton algae at each station was estimated by measuring chlorophyll a concentrations. A measured volume of lake water was filtered through a Gelman type A-E glass fiber filter and the filters were stored over dessicant and frozen until analyses could be completed. Total concentrations were determined by using the methods of Richards and Thompson (1952) and Yentsch and Menzel (1963). Finally, chlorophyll a values were calculated by using the equations of Parsons and Strickland (1963). Corrections for phaeophytin were not made.

Results are listed in Appendix A.

THE SPRINGS

A spring is the water discharged as natural leakage or overflow from an aquifer through a natural opening in the ground. Along the Santa Fe River these openings are located along a fault zone as described earlier. Some of the springs are almost unnoticeable and may occur in the form of a vent in the river itself. Most, however, are set back off the river in the floodplain with their clear water forming a noticeable interface with the tannin-stained Santa Fe River. Meinzer (1927) classified springs by magnitude and assigned values from one to eight on the basis of their volume of flow or discharge. Most of the springs sampled were on the order of 1-3 magnitude. Of the 78 first magnitude springs in the United States, Florida has 27, the most for a single state. Rosenau (1977) listed only one spring, Hornsby, as a first magnitude spring, however, on the basis of Meinzer's classification system, both Poe and Devil's Eye may be added to this category. Average discharge is classified as follows: first-magnitude, 100 ft^3/sec or more; second-magnitude, 10-100 ft^3/sec; third-magnitude, 1-10 ft^3/sec; fourth to eighth-magnitude, all under 1 ft^3/sec.

The springs help to buffer changes in water levels due to rainfall because of the much greater volume of water in Florida's artesian aquifer compared with the relatively small amount of runoff into the river. Total discharge from the springs sampled was 1214.5 ft^3/sec.

The average temperature of the springs in this area is 70° F, primarily due to the shallowness of the aquifer.

The springs are listed as they appear moving downstream. Only springs with a detectable flow were included. A table of chemical analyses follows the spring descriptions in Appendix C.

Results

The two questions of major concern addressed in the present study were:

1) Does water chemistry significantly differ between sites?
2) Is water chemistry significantly affected by changes in river flow?

To test the first question, a Duncan's multiple range test was run for each variable. Mean values were calculated for the eight samples taken at each station. These means were statistically compared at the .05 level of significance.

All of the variables which showed significant differences between sites were graphed (Table 2). Means connected by a single bar are not significantly different.

Mean values for pH at sites 1-3 were significantly different from mean values at sites 4-12. Site 4 was not significantly different from sites 5-12 but was similar to sites 1-3 with values ranging from 6.44-7.48. Values at site 5-12 ranged from 6.44-7.48 but mean pH was higher than at site 4.

Table 2

pH

Station	1	2	3	4	5	7	6	11	9	12	10	8
Mean Value	5.7	6.1	6.4	6.5	7.0	7.2	7.2	7.3	7.4	7.4	7.4	7.4

Alkalinity

Station	2	3	1	4	6	5	9	11	10	12	7	8
Mean Value	39.4	44.1	63.9	108.3	129.5	130.9	146.1	146.5	146.5	147.3	150.6	151.6

Hardness

Station	2	1	3	4	10	12	11	9	6	5	8	7
Mean Value	79.9	87.0	99.5	143.4	177.1	184.0	194.6	206.3	221.1	223.6	228.1	263.3

Table 2

Specific Conductance

Station	1	2	3	4	9	10	12	11	8	7	6	5
Mean Values	140.0	146.9	157.0	263.5	299.4	307.5	308.6	308.8	310.0	314.4	377.5	382.5

Turbidity

Station	7	9	8	12	11	6	10	1	4	5	3	2
Mean Values	0.65	0.68	0.70	0.91	0.98	0.99	1.00	1.04	1.12	1.23	1.88	1.90

Phosphorous

Station	9	7	12	6	8	2	5	10	4	11	1	3
Mean Values	62.2	62.9	65.3	79.3	79.5	81.7	89.3	105.5	113.3	154.2	185.0	348.4

Table 2

Flow

Station	2	3	1	5	4	6	7	12	9	11	10	8
Mean Value	1.2	1.6	2.3	2.7	3.0	7.3	28.0	33.4	36.5	49.3	54.1	64.8

Iron

Station	11	7	9	8	12	10	5	6	3	2	4	1
Mean Value	.023	.023	.023	.023	.027	.036	.093	.120	.270	.280	.300	.360

Alkalinity values at sites 1-3 ranging from 0-113 mg/l were significantly different from values of 0-160 mg/l at sites 4-12. Hardness values at sites 1-3 were also significantly different from values at sites 5-12. Waters containing more than 100 mg/l calcium and magnesium cations are considered very hard (Furfor and Becker, 1964).

Specific conductance at sites 1-3 was again significantly different from sites 4 and 7-12 and from sites 5 and 6.

Values for turbidity at sites 2 and 3 were significantly different from sites 1 and 4-12 with a minimum value at sites 2 and 3 of twice the minimum value at all other sites.

Station 3 was the only station with phosphorous values significantly different from other stations. Values ranged from 61.90-753.90 mg/m^3 while values ranged from 0-566.70 mg/m^3 at all other stations.

Discharge values at the first six stations were well below those at sites 7-12 where springs dramatically increased the total volume of water in the river.

Finally, total iron concentration at sites 1 and 4 were significantly greater than at the rest of the sites.

The next question was which, if any, of the variables were affected by changes in river flow? The sites at which most variables were found to be statistically alike in the Duncan's test were grouped together for analysis. Sites 1-3 made up section 1, sites 4 and 5 made up section 2, and section 3 was a composite of sites 6-12. For each section, all data for each variable was plotted against corresponding flows and a regression equation was calculated for each group of data points. The graphs are listed in Appendix D and the regression equation for each variable is given.

For section 1, six of the variables showed significant changes at the .05 level with fluctuation in flow. Due to the small samples, however, the "goodness-of-fit" indicated by the r^2 value may not be entirely significant.

Values for pH, alkalinity, and, specific conductance and total hardness generally decreased with increases in streamflow. Total iron and total nitrogen concentrations and color units generally increased with increases in streamflow.

For section 2, seven of the variables showed significant changes with changes in streamflow.

The following variables generally decreased with an increase in streamflow: pH, alkalinity, specific conductance, color units, dissolved oxygen and total phosphorus concentrations. The only variable that increased in concentration with flow increases was total nitrogen.

The only variable in section 3 which was significantly affected by streamflow was specific conductance. The r^2 value was very low at 0.16 and the regression equation was $y = 340.691 + 0.5747x$.

Values for pH, alkalinity, hardness and conductivity were all plotted on one graph for each of the twelve original stations so that the effect on each by changes in streamflow could be easily compared (Appendix E). The fluctuations in values for each of these variables were similar at stations 1-6, whereas at stations 7-12 values were much more variable with no definite pattern shown.

DISCUSSION

Variation in water chemistry along the Santa Fe River can best be explained by geological variation. The high concentration of total phosphorus, for example, in the upper segments of the river is caused by the underlying phosphatic clays of the Hawthorne formation. The boundaries of this formation in Alachua County were mapped (Odum,1953) and corresponding phosphorus concentrations were listed (Figure 4). Concentrations found in this study are in agreement with those listed earlier. The fact that station 3 lies below the point of inflow of treated water from the Raiford and Lake Butler sewage plants may contribute to the much higher phosphorus level found there. The higher concentration of total iron in the first three stations is probably due to amorphous clays and outflow from the Santa Fe swamp. Particularly after heavy rains, the iron concentration was much higher presumably due to inflowing swamp water containing appreciable amounts of iron. It is commonly believed that functional groups associated with humic acid molecules in colored water produce soluble chelates with ferrous and ferric iron and thus increase solubility of iron (Dierberg, 1980). Iron concentrations in samples taken after heavy rains (0.3-0.9 mg/l) increased to within the range found in swampwater samples taken in Georgia by Beck (1974). Total hardness, specific conductance, pH and alkalinity values, which were lower than downstream values, may also have been reduced by inflow of acidic swampwater after rains. The characteristically acid nature of rainwater in north Florida (Brezonik, 1980) may also contribute to lowered pH values in shallower segments of the river.

Values for pH, alkalinity, hardness and conductivity all increased significantly at sites 4 and 5. Near site 5, the river begins to cut into the Limestone Plain allowing highly mineralized water from the aquifer to dilute the acidic runoff water.

The significant increase in total hardness, pH, alkalinity, and specific conductance at the last six stations is due to inflow from the many springs

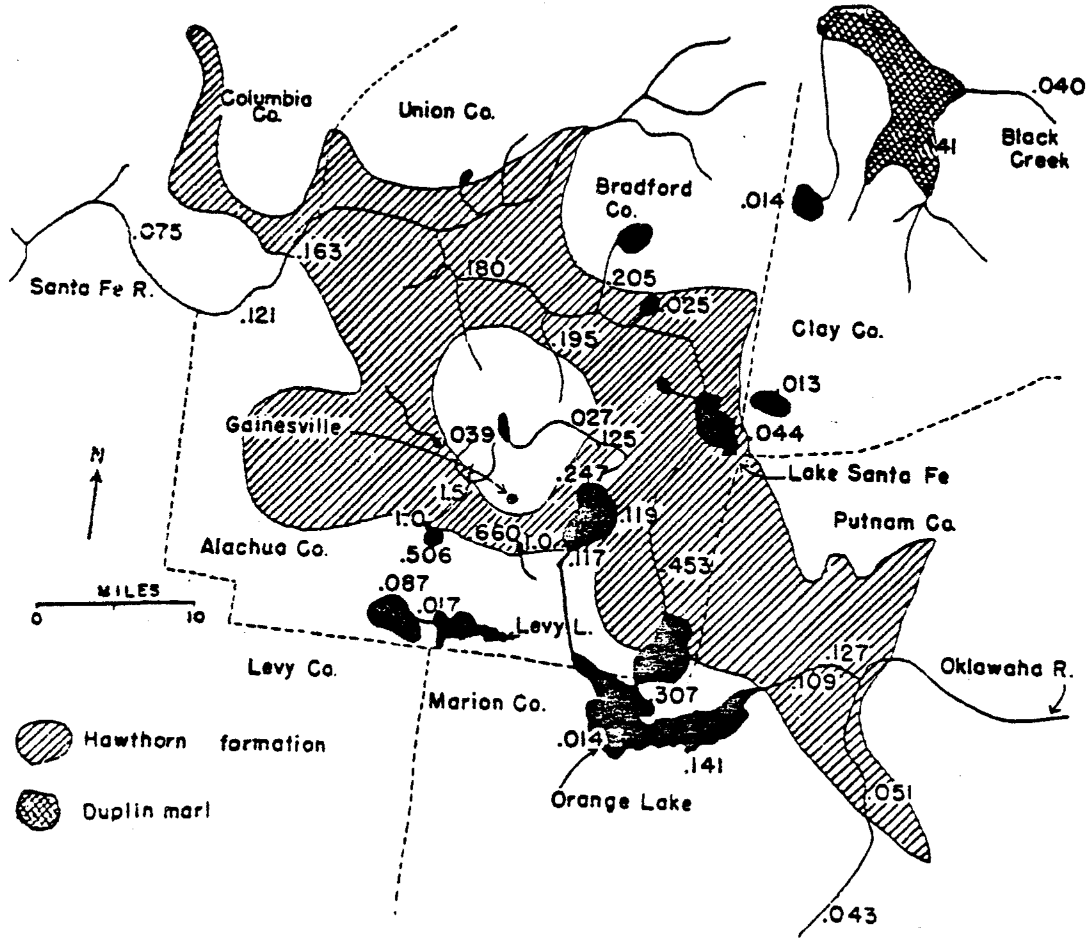

Figure 4. Phosphorus concentrations in Alachua County taken from Odum (1953).

containing dissolved carbonates in limestone and dolomite. Values for phosphorus and nitrogen were not significantly different from those upstream, although phosphorus levels for sites 10 and 11 were higher than those at sites 6-10. Schomer and Hand (1980) described significant loading rates for these downstream areas (Table 3) based on land use and published pollution loading rates. It is difficult to pinpoint sources of pollution along the river because of dilution by springflow. Since phosphorus standards do not exist in Florida, Schomer used an arbitrary value 0.1 mg/l of phosphorus for comparison purposes. The difficulty with setting such standards lies in the varied geology of this area and flow factors. In areas of greater flow to drainage area ratios, a higher allowable loading rate would have to exist. It is imperative to further investigate the geology of the river basin in order to understand the validity of setting loading rates for nutrients. The effect of nutrient loading on the diverse aquatic life in the river should also be documented.

It is clear that because of large fluctuations in streamflow, the periodic link with the Santa Fe swamp, and the constant inflow of water from the aquifer, any modifications in these areas would alter the water quality of the river.

TABLE 3

Land Use Phosphorus Loading Rates for the Six
Santa Fe Subsegments taken from Schomer and Hand (1980)

				Phosphorus Load	
Subsegment	Urban	Cultivated	Forest*	Kg/yr	lbs/day
SFUP	674	3074	20898	6512	39
NEW	767	8146	40214	13701	83
SFMID	1821	18259	54588	27360	165
OLUST	221	3819	38892	8150	49
ICH	2570	23395	29210	31456	190
SFMOUTH	1662	42676	60232	52023	314

*Includes forest, barren, water and wetland land uses

Segments of the river listed are:

SFUP = upstream from Brooker; SFMID = Brooker to O'leno; OLUST = segment with Olustee Creek; ICH = segment surrounding Ichetucknee River; SMOUTH = segment downstream of O'leno to the Suwannee River.

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APPENDIX A

STATION 1

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	23.5	4.9	Bottom	0	0.5	6.55	98	114
6/9/81	26.4	3.2	Bottom	0	0.5	6.50	88	113
6/21/81	27.5	8.4	Bottom	0	0.5	6.60	100	71
7/5/81	27.5	8.4	Bottom	0	0.5	7.23	112	107
7/21/81	27.0	6.6	Bottom	0	0.5	6.62	113	78
8/4/81	26.0	4.8	0.75	484.2	2.0	4.22	0	7
8/10/81	24.5	3.2	0.65	81.3	2.8	3.53	0	8
8/30/81	23.8	6.1	Bottom	149.0	1.4	4.42	0	8

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll a mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	123	150	7.578	566.7	0.40	40	0.129	0.126
6/9/81	123	160	6.749	437.8	1.50	35	0.579	0.233
6/21/81	108	190	2.989	246.5	0.70	30	-	0.183
7/5/81	136	230	0.497	162.0	0.80	30	0.230	0.153
7/21/81	120	213	8.740	32.2	1.25	35	-	0.132
8/4/81	12	57	-	1.4	0.90	600	1.157	0.507
8/19/81	26	63	0.636	29.9	0.75	600	1.443	0.941
8/30/81	48	57	2.245	3.6	2.00	600	1.220	0.572

STATION 2

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	24.5	8.0	Bottom	0	0.40	6.60	74	92
6/9/81	26.0	6.1	Bottom	0	0.20	6.35	68	96
6/21/81	28.0	5.8	Bottom	0	0.20	6.09	55	61
7/5/81	28.0	5.8	Bottom	0	0.20	6.64	30	50
7/21/81	29.0	8.6	Bottom	0	0.10	6.68	59	76
8/4/81	24.5	3.8	0.75	121.3	1.00	5.07	4	20
8/19/81	25.0	5.2	0.65	141.0	2.60	5.38	13	26
8/30/81	24.0	5.2	Bottom	96.1	1.10	5.68	12	24

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll a mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	108	170	8.205	86.4	-	-	0.321	0.077
6/9/81	107	175	7.901	143.1	2.0	-	0.579	0.071
6/21/81	79	165	1.699	154.1	2.3	160	0.474	0.087
7/5/81	97	135	2.288	84.9	1.90	250	1.122	0.519
7/21/81	78	140	1.522	157.5	1.40	60	0.383	0.065
8/4/81	60	146	1.388	3.3	1.50	400	1.429	0.344
8/19/81	62	125	0.715	28.2	2.40	350	1.116	0.607
8/30/81	48	119	1.877	16.8	1.6	325	0.983	0.467

STATION 3

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/26/81	24.5	6.4	Bottom	8.6	0.8	6.70	68	86
6/9/81	25.0	5.2	Bottom	10.7	1.1	6.38	73	94
6/21/81	25.5	5.0	Bottom	21.3	1.1	6.34	71	67
7/5/81	25.5	5.0	0.75	21.3	1.0	6.64	30	183
7/21/81	28.5	4.6	1.40	9.0	1.6	6.75	41	52
8/4/81	26.5	5.6	1.20	178.4	1.9	6.50	21	56
8/19/81	26.0	5.4	0.75	79.6	3.7	5.65	22	36
8/30/81	24.5	5.5	0.80	0.8	1.5	6.38	27	40

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/26/81	91	190	3.982	467.5	1.50	-	0.165	0.181
6/9/81	115	190	19.448	613.1	2.05	-	0.404	0.126
6/21/81	171	200	1.521	84.9	1.90	300	1.095	0.017
7/5/81	185	135	1.808	152.0	1.20	300	0.181	0.479
7/21/81	64	148	20.156	753.9	1.75	175	0.760	0.359
8/4/81	60	143	2.209	65.6	2.20	250	0.920	0.304
8/19/81	58	120	0.854	69.0	2.40	250	1.234	0.615
8/30/81	52	130	2.893	61.9	2.20	225	1.143	0.523

STATION 4

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	24.5	5.7	Bottom	126.9	1.0	6.80	137	171
6/9/81	26.0	4.2	Bottom	64.5	1.0	6.55	143	211
6/21/81	26.0	8.2	Bottom	43.0	1.0	6.60	137	67
7/5/81	26.0	8.2	Bottom	43.0	1.0	7.76	126	65
7/21/81	25.5	4.7	Bottom	63.4	1.0	7.22	136	124
8/4/81	27.0	5.6	Bottom	31.62	1.0	7.36	111	138
8/19/81	26.5	2.8	Bottom	288.1	4.0	3.33	0	10
8/30/81	24.5	4.5	Bottom	139.3	1.3	6.45	76	114

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	188	300	1.598	126.1	0.70	-	0.194	0.046
6/9/81	211	310	2.236	83.1	1.75	-	0.108	0.070
6/21/81	173	300	2.222	166.9	1.40	280	0.180	0.064
7/5/81	108	320	2.755	152.0	1.20	300	0.181	0.479
7/21/81	178	310	3.070	210.6	0.80	35	0.153	0.073
8/4/81	150	280	1.873	124.5	1.20	15	0.237	0.506
8/19/81	28	78	0.802	0	0.70	600	1.367	0.921
8/30/81	112	210	2.547	43.2	1.20	175	0.586	0.272

STATION 5

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	23.0	4.2	Bottom	69.4	0.75	6.85	140	201
6/9/81	24.2	6.0	Bottom	78.1	0.75	6.44	145	200
6/21/81	25.5	7.0	Bottom	69.4	0.75	7.08	155	184
7/5/81	25.5	7.0	Bottom	69.4	0.75	7.35	141	218
7/21/81	25.0	5.2	Bottom	64.7	0.70	7.22	138	206
8/4/81	27.0	5.4	Bottom	173.5	0.75	7.48	146	204
8/19/81	27.0	5.0	Bottom	95.7	2.40	6.71	80	128
8/30/81	24.5	4.2	Bottom	211.2	0.50	7.00	102	180

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	232	390	1.305	98.4	0.40	10	0.265	0.032
6/9/81	240	390	1.277	97.4	1.40	10	0.287	0.020
6/21/81	232	400	0.253	94.9	0.55	15		0.015
7/5/81	227	430	2.961	109.2	0.50	15	0.181	0.089
7/21/81	224	410	4.906	157.5	0.80	20	0.216	0.026
8/4/81	240	430	4.140	67.1	0.60	15	0.160	0.017
8/19/81	134	270	1.258	46.5	0.90	225	0.767	0.348
8/30/81	260	340	5.994	43.6	1.40	70	0.697	0.200

STATION 6

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	22.0	5.7	Bottom	60.2	2.0	7.24	141	233
6/9/81	25.5	9.0	Bottom	60.2	2.0	6.62	148	195
6/21/81	26.0	4.8	Bottom	90.4	2.0	6.90	149	192
7/5/81	25.5	5.2	Bottom	90.4	2.0	7.52	139	230
7/21/81	25.5	4.7	Bottom	103.9	2.3	7.43	137	196
8/4/81	26.5	4.2	Bottom	90.4	2.0	7.44	144	182
8/19/81	25.5	1.8	Bottom	90.6	2.0	6.75	80	176
8/30/81	25.5	3.2	Bottom	85.4	2.0	7.90	98	132

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll a mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	239	385	1.755	105.0	0.90	10	0.287	0.091
6/9/81	210	380	1.702	102.7	1.75	15	0.156	0.029
6/21/81	229	400	1.733	66.3	0.50	15	0.194	0.015
7/5/81	231	420	1.800	100.7	0.70	15	0.125	0.032
7/21/81	206	405	2.350	154.7	0.60	20	0.160	0.016
8/4/81	262	415	0.754	20.5	0.60	15	0.160	0.163
8/19/81	220	290	2.414	48.4	1.25	250	0.913	0.323
8/30/81	172	325	-	36.2	1.60	150	0.525	0.293

STATION 7

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	23.5	7.6	Bottom	806.7	1.0	7.35	154	179
6/9/81	23.2	7.0	Bottom	645.5	1.0	6.64	154	180
6/21/81	24.0	7.2	Bottom	774.4	1.0	6.97	156	159
7/5/81	-	-	Bottom	1371.4	1.7	7.35	154	420
7/21/81	23.8	5.4	Bottom	1371.0	1.7	7.34	154	168
8/4/81	24.0	6.1	Bottom	1032.6	1.6	7.30	152	150
8/19/81	23.5	3.1	Bottom	1536.8	1.9	7.21	138	156
8/30/81	23.5	4.3	Bottom	1567.7	1.8	7.52	145	156

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	189	300	1.702	60.7	0.20	15	-	0.011
6/9/81	200	300	1.720	45.0	1.25	10	0.223	0.008
6/21/81	187	325	1.820	68.8	0.50	10	0.668	0.004
7/5/81	460	320	1.750	56.5	0.50	10	-	0.005
7/21/81	190	320	2.913	78.4	0.50	10	0.223	0.006
8/4/81	320	320	1.134	10.0	0.40	5	-	0.006
8/19/81	360	320	0.541	90.5	0.74	70	0.892	0.079
8/30/81	200	310	3.317	93.3	1.10	25	0.662	0.063

STATION 8

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	22.5	9.2	Bottom	3700.0	7.0	7.42	151	183
6/9/81	24.5	7.0	Bottom	3700.0	7.0	6.92	159	182
6/21/81	24.0	8.0	Bottom	3705.0	7.0	7.29	155	159
7/5/81	24.0	8.0	Bottom	2065.1	2.4	7.64	154	460
7/21/81	24.0	6.2	Bottom	2322.6	2.4	7.51	154	186
8/4/81	24.1	5.3	Bottom	3872.1	4.0	7.63	152	180
8/19/81	24.0	3.5	Bottom	1870.8	1.5	7.43	140	146
8/30/81	23.8	2.9	Bottom	2760.5	5.1	7.71	148	188

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	202	300	0.900	47.4	0.20	10	0.223	0.010
6/9/81	202	300	0.932	63.6	1.0	10	0.194	0.007
6/21/81	191	330	1.839	102.3	0.50	10	0.553	0.007
7/5/81	464	320	2.202	59.9	0.50	10	0.404	0.012
7/21/81	194	320	2.440	74.8	0.50	10	0.453	0.007
8/4/81	204	340	0.818	107.5	0.50	0	2.426	0.008
8/19/81	172	310	3.076	89.0	1.10	60	0.865	0.079
8/30/81	196	260	3.137	91.8	1.20	25	0.634	0.051

STATION 9

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	23.8	8.0	Bottom	906.1	2.7	7.43	151	194
6/9/81	23.5	8.2	Bottom	1328.4	2.5	7.00	160	178
6/21/81	24.0	7.3	Bottom	1698.9	2.7	6.63	151	160
7/5/81	24.0	6.7	Bottom	1774.4	2.7	7.61	150	228
7/21/81	24.0	5.3	Bottom	2012.9	3.0	7.62	153	172
8/4/81	24.2	6.0	Bottom	1879.3	3.2	7.50	155	184
8/19/81	24.5	4.8	Bottom	1431.0	3.0	7.31	120	140
8/30/81	23.5	6.0	Bottom	1156.2	2.8	7.80	132	216

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N Mg/m^3	Total FE mg/l
5/25/81	226	300	-	56.6	0.30	5	0.230	0.015
6/9/81	193	300	1.980	59.3	1.25	10	0.272	0.010
6/21/81	185	310	2.365	59.0	0.50	5	0.503	0.007
7/5/81	232	340	0.910	59.9	0.60	5	0.439	0.012
7/21/81	206	330	1.485	75.2	0.50	5	0.509	0.008
8/4/81	220	300	0.145	78.0	0.40	0	-	-
8/19/81	140	235	2.589	48.8	0.36	60	0.976	0.006
8/30/81	248	280	1.694	61.4	1.50	30	0.945	0.103

STATION 10

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	23.5	7.1	Bottom	2168.4	3.2	7.60	151	176
6/9/81	23.0	7.2	Bottom	1897.3	1.8	7.12	151	178
6/21/81	23.5	7.1	Bottom	2352.3	2.0	6.35	148	147
7/5/81	24.0	6.8	Bottom	2516.9	2.0	7.51	145	220
7/21/81	24.0	4.2	Bottom	3145.1	2.5	7.63	149	172
8/4/81	23.5	5.8	Bottom	2300.1	2.2	7.70	154	168
8/19/81	24.0	4.3	Bottom	1441.7	2.1	7.44	138	78
8/30/81	23.0	5.8	Bottom	1656.5	2.2	7.95	136	120

Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	198	295	-	63.2	0.40	5	-	0.023
6/9/81	193	305	1.097	62.8	1.30	5	0.579	0.012
6/21/81	182	295	2.871	60.6	2.20	5	0.395	0.012
7/5/81	226	310	0.440	57.8	0.75	5	0.502	0.013
7/21/81	184	330	1.471	71.8	0.70	5	0.600	0.015
8/4/81	188	335	1.326	411.6	1.20	2.5	0.390	0.015
8/19/81	78	315	2.118	107.3	0.83	60	0.802	0.062
8/30/81	168	275	1.538	8.7	0.60	10	0.904	0.132

STATION 11

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
5/25/81	23.5	7.1	Bottom	1526.3	4.3	7.34	147	186
6/9/81	23.0	6.2	Bottom	1703.7	3.6	7.10	149	157
6/21/81	24.9	6.0	Bottom	2395.9	3.8	6.40	149	158
7/5/81	24.0	6.2	Bottom	2981.5	4.2	7.36	142	240
7/21/81	24.0	5.2	Bottom	2071.0	2.5	7.63	149	158
8/4/81	24.0	5.3	Bottom	2319.0	3.5	7.70	154	148
8/19/81	23.8	4.0	Bottom	2929.5	4.8	7.44	136	172
8/30/81	23.5	5.6	Bottom	1945.9	4.0	7.60	146	156

Date	Total Hardness Mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll a mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	197	295	1.708	58.2	0.60	15	0.356	0.035
6/9/81	181	295	1.946	62.8	1.50	10	1.060	0.010
6/21/81	183	295	1.410	53.0	0.50	10	0.330	0.017
7/5/81	250	300	1.454	58.6	0.75	10	0.544	0.021
7/21/81	186	320	1.474	65.4	0.80	0	0.544	0.017
8/4/81	184	330	0.731	826.2	0.75	0	0.544	0.020
8/19/81	188	300	1.789	92.0	1.00	40	0.739	0.058
8/30/81	188	335	2.481	17.2	1.90	15	0.621	0.002

STATION 12

Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Hardness mg/l $CaCO_3$
5/25/81	-	-	-	-	-	-	-	-
6/9/81	23.0	6.2	Bottom	1532.7	3.8	6.80	152	158
6/21/81	24.0	6.2	Bottom	1226.2	3.8	7.00	147	155
7/5/81	24.0	6.4	Bottom	1236.0	2.8	7.49	146	180
7/21/81	24.0	5.3	Bottom	1412.1	3.2	7.68	146	158
8/4/81	24.0	6.0	Bottom	1220.5	3.3	7.84	156	164
8/19/81	24.0	4.8	Bottom	1061.8	3.1	7.43	140	184
8/30/81	23.5	5.8	Bottom	772.7	2.8	7.57	144	168

Date	Total Hardness Mg/l $CaCO_3$	Specific Conductance μmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
5/25/81	-	-	-	-	-	-	-	-
6/9/81	182	290	1.380	60.1	1.40	5	0.531	0.017
6/21/81	178	300	1.318	56.8	0.45	2.5	0.323	0.018
7/5/81	194	295	1.759	55.3	0.80	5	0.418	0.018
7/21/81	174	310	1.426	65.8	0.70	0	0.404	0.018
8/4/81	188	330	2.926	111.8	0.75	2.5	0.593	0.021
8/19/81	204	305	0.700	91.3	1.20	40	0.774	0.059
8/30/81	168	330	1.602	16.2	1.10	50	0.746	0.038

Station	Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Depth Meters	pH	Total Alklalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
a	8/19/81	32.0	5.3	Bottom	0	0.50	5.20	4	10
b		24.5	2.1	Bottom	5.89	0.95	3.94	0	6
c		24.5	1.4	Bottom	3.76	1.0	4.30	0	4

Station	Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll a mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
a	8/19/81	10	59	4.050	5.3	1.75	30	0.321	0.088
b		10	58	0.857	4.9	1.90	450	1.499	0.788
c		28	280	0.061	14.7	1.50	400	1.353	0.842

APPENDIX B

The following locations were sampled biweekly starting May 25, 1981 and ending August 30, 1981:

Station #1 - at the Hwy 225 bridge near Graham, Florida
#2 - near Brooker, on SR 231 at the bridge
#3 - near Worthington Spgs., on SR 121
#4 - north of O'leno State Park, just west of the I-75 bridge
#5 - just west of the US Hwy 441 bridge at the boat ramp (site of the old bridge)
#6 - at the SR Hwy 27 bridge just north of High Springs
#7 - about 1 mile south of Ginnie Springs at the USGS sampling station north of SR 47
#8 - at the SR 47 bridge west of Fort White
#9 - about 0.2 miles north of the point of Ichetucknee River
#10 - 0.1 mile south of point of entry of Ichetucknee River into the Santa Fe
#11 - just upstream of the US Hwy 129 bridge near Bell
#12 - just north of the confluence with the Suwannee River near Bell, about 2.0 miles south of the US Hwy 127 bridge

Station a - located at the point of origin of the Santa Fe River at Little Santa Fe Lake at the edge of the cypress swamp On August 19, 1981 there was no flow at the inlet and depth was only 0.5 meters. Water temperature at this point was 32.0° C.

Station b - This point was sampled from the bridge on Hwy 325 where it crosses the Santa Fe swamp. Discharge was recorded as 5.9 ft^3/sec on August 19, 1981. Maximum depth was 1 meter and temperature was 24.5° C.

Station c - Sampling took place from the bridge on US Hwy 301, about 3 miles north of Waldo. Several small streams were flowing out of the cypress swamp and the most prominent one was sampled. Discharge at this point was 3.8 ft^3/sec on August 19, 1981. Depth was one meter and temperature was 24.5° C.

New River - Joins the Santa Fe approximately 0.6 miles upstream of SR 121 at Worthington Springs. Four creeks contribute to it's flow which was 51.46 ft^3/sec on August 19, 1981. Water temperature was 25.2 degrees C.

APPENDIX C

Hornsby

Located at lat. 29°50'59" N., long. 82°35'36" W., it lies about 1.5 miles N. of High Springs, within Camp Kuluqua property. The spring forms an elliptical pool about 125 ft. wide and 185 ft. long. It runs through a swamp forest westerly into a sink and probably reemerges in the Santa Fe River less than half a mile beyond the sink. It is not easily detectable, however. Hornsby Springs provides evidence of being dry to levels of over 160 ft. below the present sea level. It has unexplored chambers extending over 200 ft. downward (Brooks 1972).

Hornsby's discharge was recorded as 250 ft^3/s on April 19, 1976 and 76 ft^3/s on April 25, 1975. On August 30, 1981 discharge was 12.0 ft^3/sec and water temperature was 22.5° C. Width of the run was 45.5 ft. and depth was 4 meters in the center.

Darby Springs, which is still listed by Rosenau (1977) in Springs of Florida, was previously flowing from a site 1/4 mile east of the Hwy 441 bridge, but was dynamited closed years ago in an attempt to deepen the swimming hole.

Columbia

Located 0.3 miles downstream from US Hwy 441, on the right bank of the river, this spring has been considered by some hydrologists as being simply a return to the surface of underground caverns that are part of the Santa Fe River. A study by Briel (1976) describing the uranium isotope ratios in ground and surface waters in the Santa Fe Basin suggests, however, that the springwater includes an appreciable groundwater component derived directly from the Floridan aquifer.

Estimated previously to be of second magnitude, flow recorded on August 30, 1981 was 125.1 ft^3/sec. Temperature was 25.2° C. Width was 83 ft. and depth was only 0.75 meters.

Poe

This spring is located about 3 miles W. of High Springs (lat. 29° 49'33" N., long. 83°38'58" W.). It forms a circular pool 90 ft. in diameter with a run 175 ft. long and about 14 ft. wide. The pool which is now 17.5 ft. deep was reportedly 19 ft. deeper fifty years ago. This spring is used extensively by locals as is evidenced by the lack of macrophytes and shoreline vegetation.

Flow was recorded as 86.5 ft^3/sec on February 19, 1971, 31.2 ft^3/sec on April 18, 1972, and 83.9 ft^3/sec on August 19, 1981.

Water temperature was 22.5° C. Depth of the run was only 1.8 meters.

Unnamed I

Allen Spring is reportedly 0.2 miles north of Poe Springs, however no spring could be detected at that location. Since this spring appeared just downstream of Poe, also on the opposite bank, it may be called Allen Spring.

This spring flows into the river from a long run through the floodplain and is only ankle-deep at the Santa Fe. At this point the flow was recorded as 57.3 ft^3/sec on August 19, 1981 and water temperature was 24.0° C.

Unnamed II

This spring appears about 0.1 mile north of Lily Springs on the left bank of the river and joins the river by a short run. This spring is darkly stained and is congested with aquatic weeds, mostly eelgrass along the run.

Flow was recorded as 72.1 ft^3/sec on August 19, 1981.

Water temperature was 22.5° C, width of the run was 6.8 ft. and depth was 3.0 meters.

Lily

Located on the left bank of the Santa Fe, these springs are 0.9 miles downstream of Poe Springs and 1.3 miles above Blue Springs.

On May 9, 1975 recorded flow was 31.5 ft^3/sec discharging through numerous vents. Flow was recorded as 12.9 ft^3/sec on August 19, 1981. Temperature was 23.9° C, depth of the run was 5 meters and width was 8.5 feet.

Rum

This spring is located about 0.1 miles upstream of and across from Blue Springs and just below Rum Island. The shoreline has recently been cemented on two sides by Gilchrist County. Like Poe Springs, it is highly utilized by locals.

Flow was recorded on August 16, 1981 as 42.6 ft^3/sec. Width of the run was 83.5 ft. and depth was 1.1 meters. Water temperature was 22.5° C.

Blue

This spring is located about 4.5 miles WNW of High Springs (lat. 29° 49'47" N., long. 82°40'59" W.). The pool is 130 ft. in diameter and lies about 1000 ft. south of Santa Fe River. Little Blue and Naked springs lie in the thick swamp forest and join the main run about 100 ft. and 500 ft. from the main pool.

The combined flow was recorded as 70.4 ft^3/sec on April 28, 1975 and at 76.8 ft^3/sec on August 16, 1981. Width of the run at the Santa Fe was 60.3 ft. and maximum depth was 0.65 meters. Water temperature at this point was 22.5° C.

Devil's Eye

This spring is located 0.2 miles north of Ginnie Springs in Gilchrist County. It discharges from a system of caverns and passages reported to be over 8,000 ft. long connecting to July Springs across the river. (Hurst, 1975).

Flow was previously estimated to be second magnitude but was recorded as 184.5 ft^3/sec on August 16, 1981 making it a first-magnitude spring. Maximum depth of the run was 1.5 meters and width was 69.5 ft. Water temperature was 22.5° C.

July

This spring is located directly across from and connecting to Devil's Eye.

The spring was reported as being a second-magnitude spring (Briel, 1976). On August 16, 1981 it was discharging at a rate of 80.7 ft^3/sec. Width of the run was 86.7 ft. and maximum depth was 1.5 meters. Water temperature was 22.0° C.

Ginnie

This spring is located about 7.5 mi. WNW of the town of High Springs, on the south bank of the river. The spring is oval in shape and approximately 200 ft. by 40 ft. The depth near the center vent is approximately 25 ft. An extensive cave system of 1,100 ft. of passages extends to the south and east of the vent and is frequently utilized by Scuba divers.

The discharge rate was recorded as 45.8 ft^3/sec on April 28, 1975 and on August 16, 1981 it was 53.9 ft^3/sec. Water temperature was 22.0 degrees C and depth of the run was 1 meter.

Dogwood

This spring lies about 0.3 miles south of Ginnie Springs within the Ginnie Spring campgrounds. It is set back off the river in a densely wooded swampy area about 60 ft. from the river. Width of the run just below the spring vent was 51.8 feet and depth was 0.5 meters. Discharge on August 16, 1981 was 10.9 ft^3/sec and water temperature was 22.5° C.

Deer

Also lying within Ginnie Springs campground, this spring is located about 0.5 miles south of Dogwood Spring. It is set behind a grassy bank just off of the river. Unlike other springs in the area,this one has a healthy growth of hydrilla which is kept under control with spraying of Diquat by the Suwannee River Management District.

Discharge was recorded on August 16, 1981 as 7.1 ft^3/sec. Water temperature was 23.0° C.

Unnamed III

Just across the river from Deer Spring is a spring set back in the swamp forest about 25 ft. from the river. The run was only 18 ft. wide and 2.3 meters deep on August 30, 1981. Discharge was 31.2 ft^3/sec and temperature was 22.2° C.

Wilson

This spring lies downstream of state Hwy 47 about 2.5 miles (lat. 29°53'59" N., long. 82°45'31" W.) on the north bank of the river. The spring run, which is almost parallel to the river, is bordered by grassy lawns sloping down to it's edge and is approximately 150 ft. long. The springwater has a dark stain and the bottom was not discernable. Spring discharge was 13 gal/min or 2.3 ft^3/sec on September 15, 1976 and on August 30, 1981 was 16.5 ft^3/sec and water temperature was 22.5° C.

Jamison

This spring lies north of the Ichetucknee River on the east side of the Santa Fe (lat. 29°55'32" N., long. 82°45'56" W.). One edge is sandbagged and surrounded by lawns. The run, which is only about 15 ft. long, is only 2.5 ft. wide.

Spring discharge on April 28, 1977 was 3 ft^3/sec and the temperature was 21.0° C. On August 19, 1981 discharge was 8.7 ft^3/sec and temperature was 21.5° C.

Ichetucknee River

This spring run starts about 5 miles N.W. of Fort White, north of US Hwy 27, and flows 6.5 miles S. and S.W. to its confluence with the Santa Fe River. Contributing to the flow along the upper 2.5 miles of the Ichetucknee are nine named and numerous unnamed springs as well as Alligator and Rose Creeks. The individual springs are described in detail by Ferguson, et al (1977).

The average width of the river is 20 ft. and average depth is 2.5 ft. The average flow measured at US Hwy 27 is 361 ft^3/sec and the minimum was 241 ft^3/sec on January 28, 1956. On August 30, 1981 flow was 325 ft^3/sec. For comparison purposes, water was taken from a point just south of the Ichetucknee on the Santa Fe and analyzed and appears in the data as Station 10. A detailed chemical analysis of the Ichetucknee River was done by the U.S. Geological Survey on April 2, 1975 (Ferguson, 1977).

Pleasant Grove

This spring is located about 0.9 miles upstream from the Suwannee on the left bank of the river at the Santa Fe Marina.

Estimated discharge was set at under 10 ft^3/s (Ferguson, 1977). On August 19, 1981 flow was recorded as 13.3 ft^3/sec making it a second-magnitude spring. Water temperature was 21.5° C.

SPRINGS

Springs	Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Run Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
Poe	8/19/81	22.5	1.0	Bottom	83.9	1.8	6.89	165	160
Lily		23.0	1.0	Bottom	12.9	5.0	7.04	169	208
Unnamed I		24.0	3.2	Bottom	57.3	0.2	6.50	120	232
Unnamed II		22.5	4.0	Bottom	72.1	3.0	6.65	152	156
Rum	8/16/81	22.5	3.2	Bottom	42.6	1.1	7.50	166	148
Blue		22.5	6.0	Bottom	76.8	0.7	7.50	146	144
Devil's Eye		22.5	4.2	Bottom	184.5	1.5	7.55	154	160
July		22.0	3.4	Bottom	80.7	1.5	7.50	160	176
Ginnie		22.0	4.5	Bottom	53.9	1.0	7.55	142	124
Dogwood		22.5	3.5	Bottom	10.9	0.5	7.65	128	124
Deer		23.0	3.4	Bottom	7.7	1.0	7.70	120	160

Springs	Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
Poe	8/19/81	184	340	0.264	0.116	0.36	0	0.349	0.007
Lily		208	360	0.208	0.087	0.38	0	0.670	0.006
Unnamed I		260	360	0.699	0.155	0.90	0	0.370	0.067
Unnamed II		188	120	0.572	0.116	0.52	0	0.488	0.027
Rum	8/16/81	188	300	0.058	0.045	0.24	0	0.474	0.003
Blue		172	270	-	0.026	0.22	0	1.367	0.004
Devil's Eye		184	315	0.147	0.038	0.21	0	1.227	0.003
July		204	315	-	0.041	0.26	0	0.955	0.003
Ginnie		148	215	0.424	0.035	0.32	0	0.927	0.003
Dogwood		136	235	0.147	0.030	1.00	0	0.634	0.004
Deer		160	230	0.307	0.037	0.26	0	0.425	0.006

SPRINGS

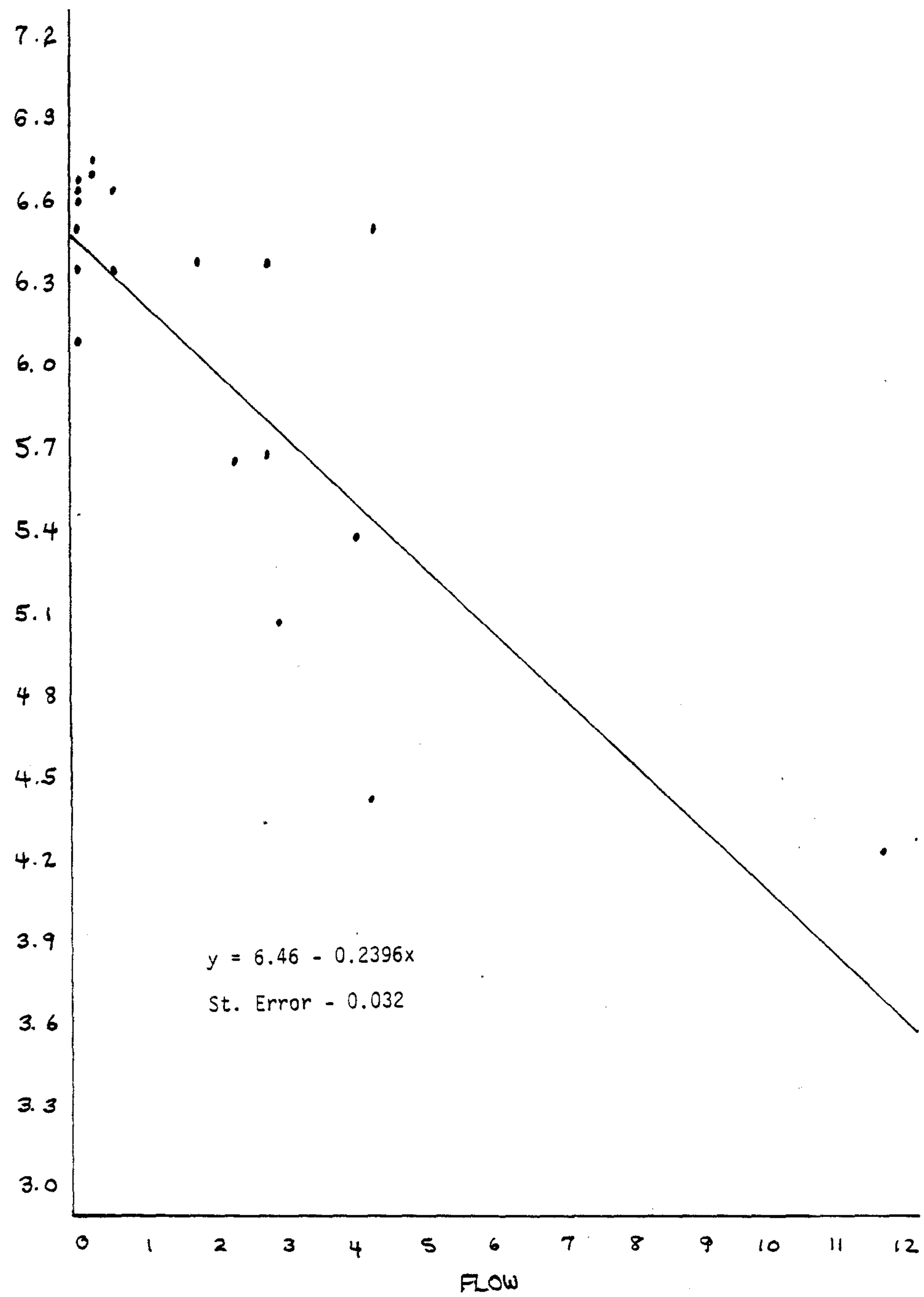
Springs	Date	Water Temperature °C	ppm Dissolved Oxygen	Secchi	Stream Discharge ft^3/sec	Run Depth Meters	pH	Total Alkalinity mg/l $CaCO_3$	Calcium Hardness mg/l $CaCO_3$
Pleasant Grove	8/19/81	21.5	1.6	Bottom	13.34	0.1	7.37	122	144
Jamison		21.5	1.4	Bottom	8.71	0.4	7.50	145	128
Wilson		22.5	2.0	Bottom	16.5	0.5	7.10	139	248
Unnamed III		22.2	2.5	Bottom	31.2	1.0	7.68	142	176
Hornsby		22.5	1.8	Bottom	11.95	4.0	7.80	152	204
Columbia		25.2	2.3	Bottom	125.1	0.8	7.70	100	152

Springs	Date	Total Hardness mg/l $CaCO_3$	Specific Conductance µmhos/cm 25C	Chlorophyll *a* mg/m^3	Total P mg/m^3	NTU Turbidity	Color mg/l Pt	Total N mg/m^3	Total FE mg/l
Pleasant Grove	8/19/81	176	260	0.356	42.1	0.40	0	0.258	0.008
Jamison		184	330	0.750	47.4	0.50	0	0.927	0.006
Wilson		248	450	-	99.5	0.70	0	0.146	0.019
Unnamed III		176	300	2.690	35.9	0.45	0	0.565	0.006
Hornsby		212	400	-	112.2	1.30	2.5	-	0.029
Columbia		172	340	-	204.8	1.20	150	-	0.223

APPENDIX D

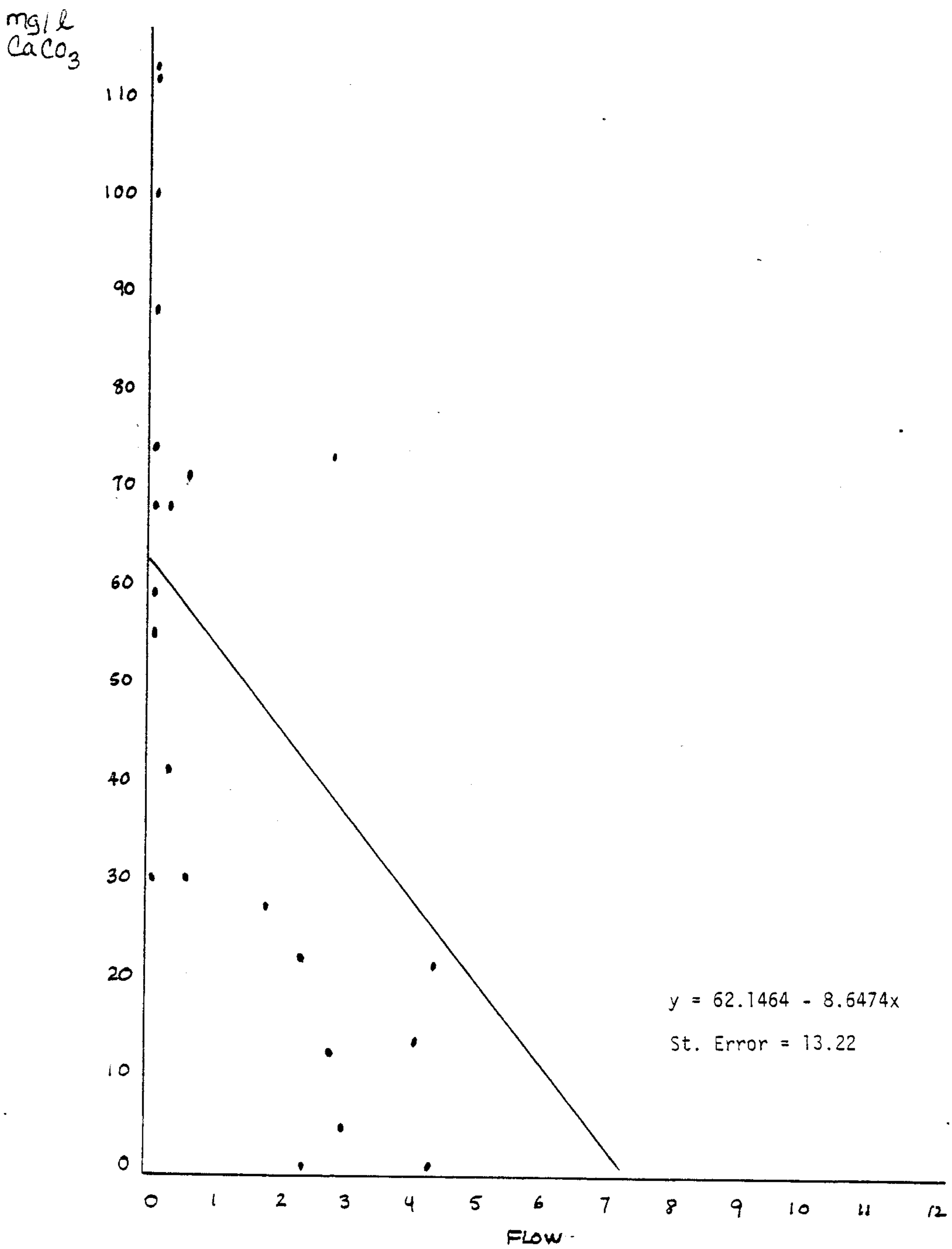
Group 1

pH



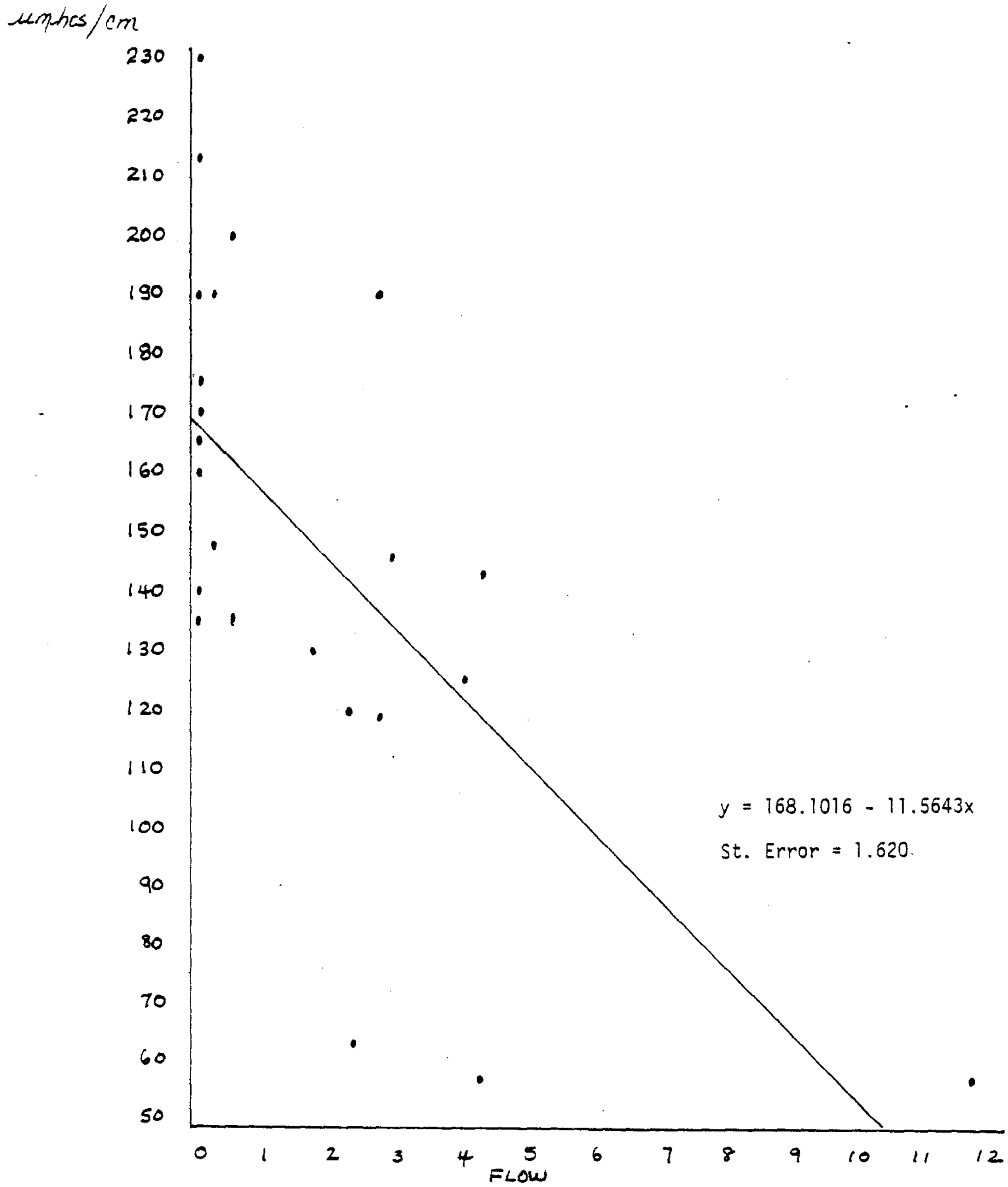
7.2
6.9
6.6
6.3
6.0
5.7
5.4
5.1
4 8
4.5
4.2
3.9
3.6
3.3
3.0
y = 6.46 - 0.2396x
St. Error - 0.032
0
1
2
3
4
5
6
7
8
9
10
11
12
FLOW

Group 1
Alkalinity



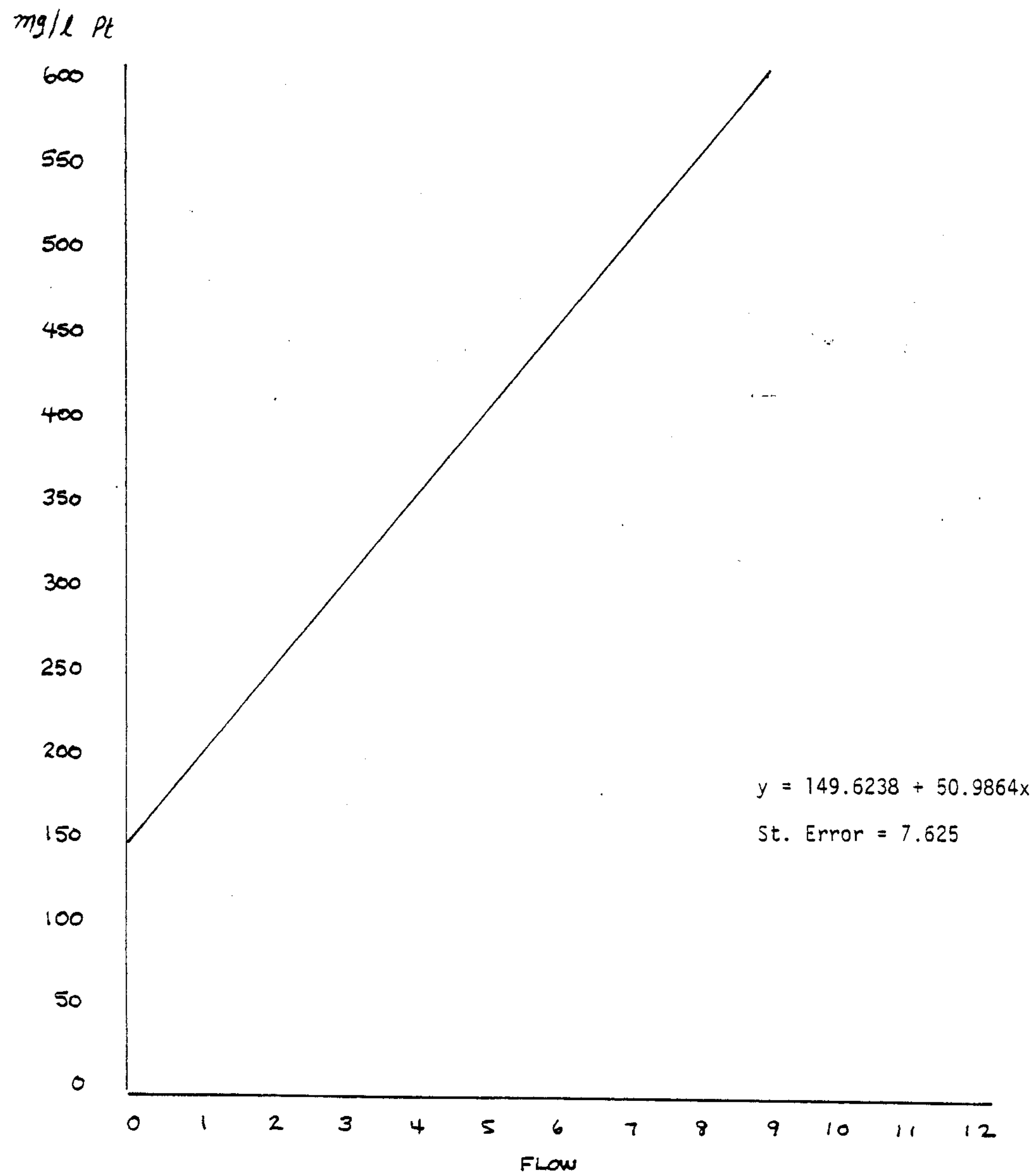
Group 1

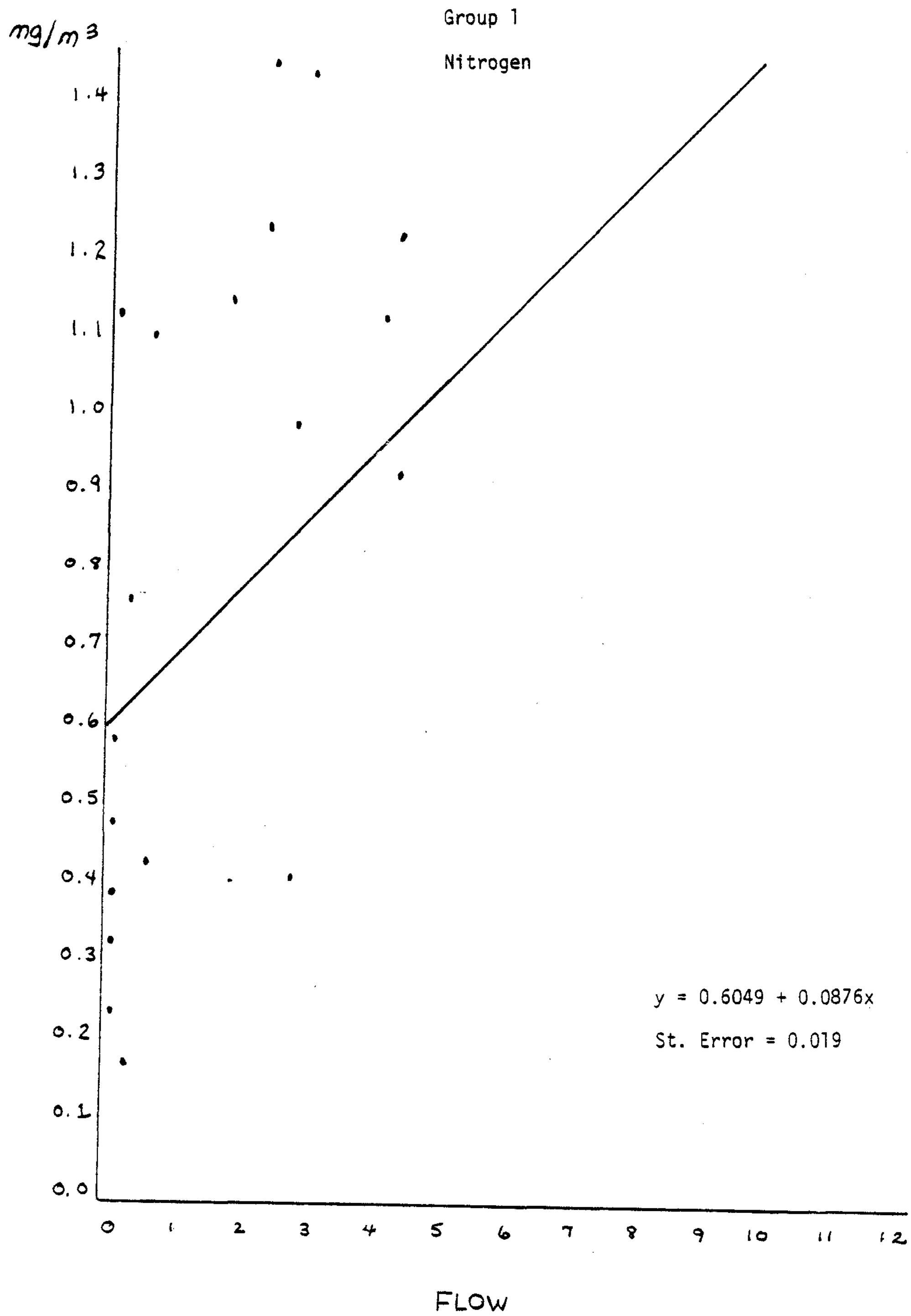
Conductivity

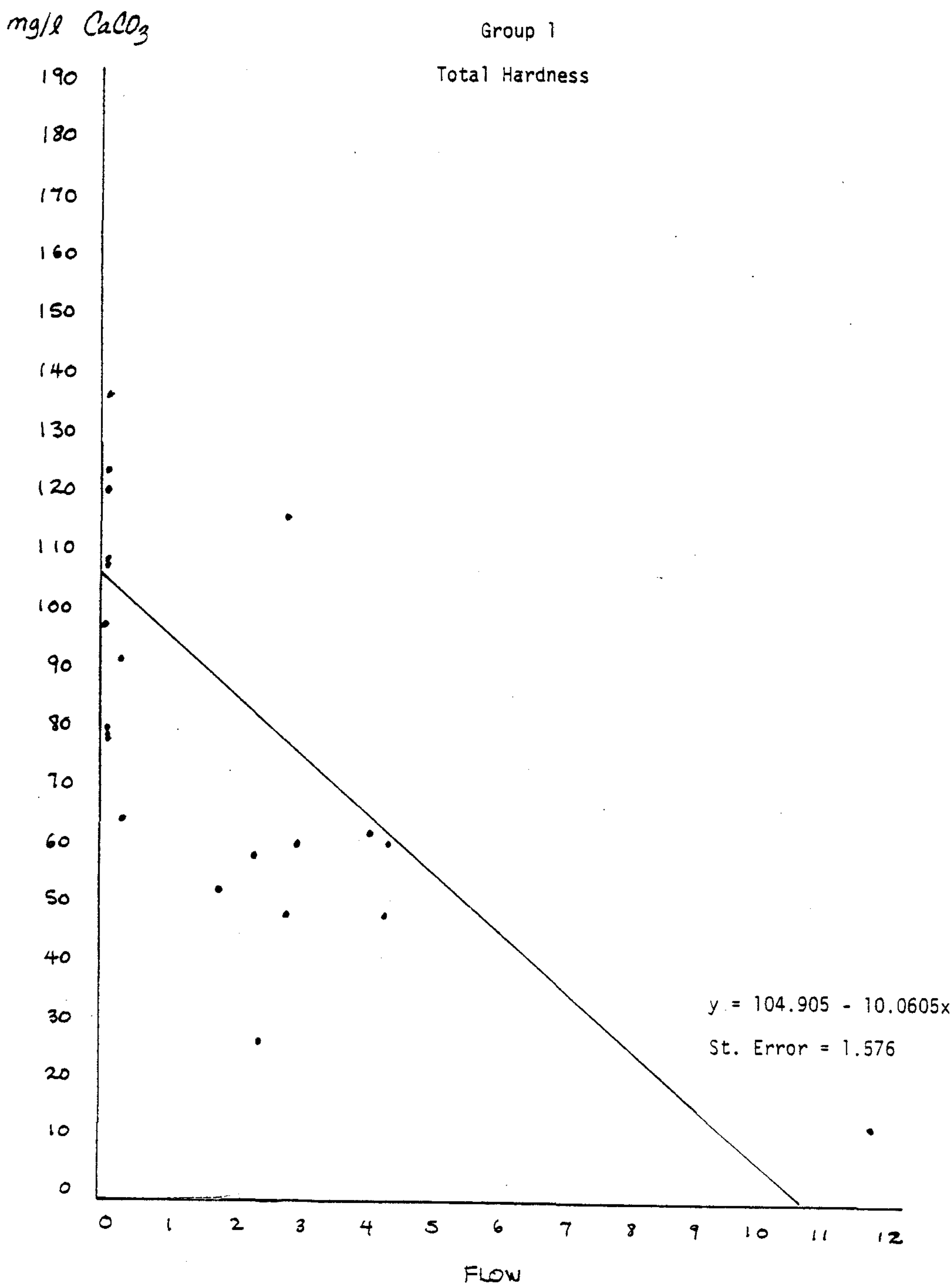


Group 1

Color

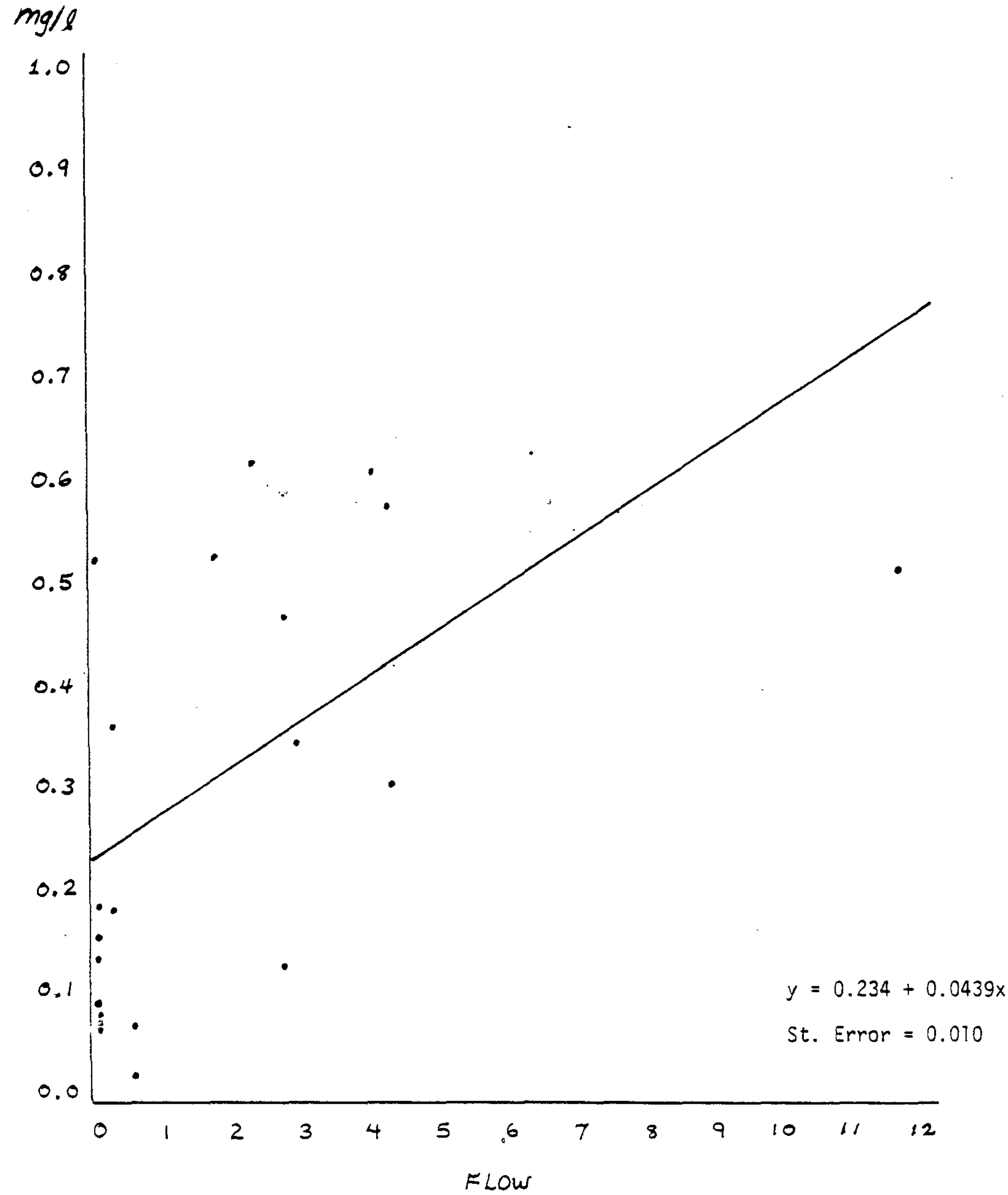



Group 1
Nitrogen
mg/m3
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
8
9
10
11
12
FLOW
y = 0.6049 + 0.0876x
St. Error = 0.019

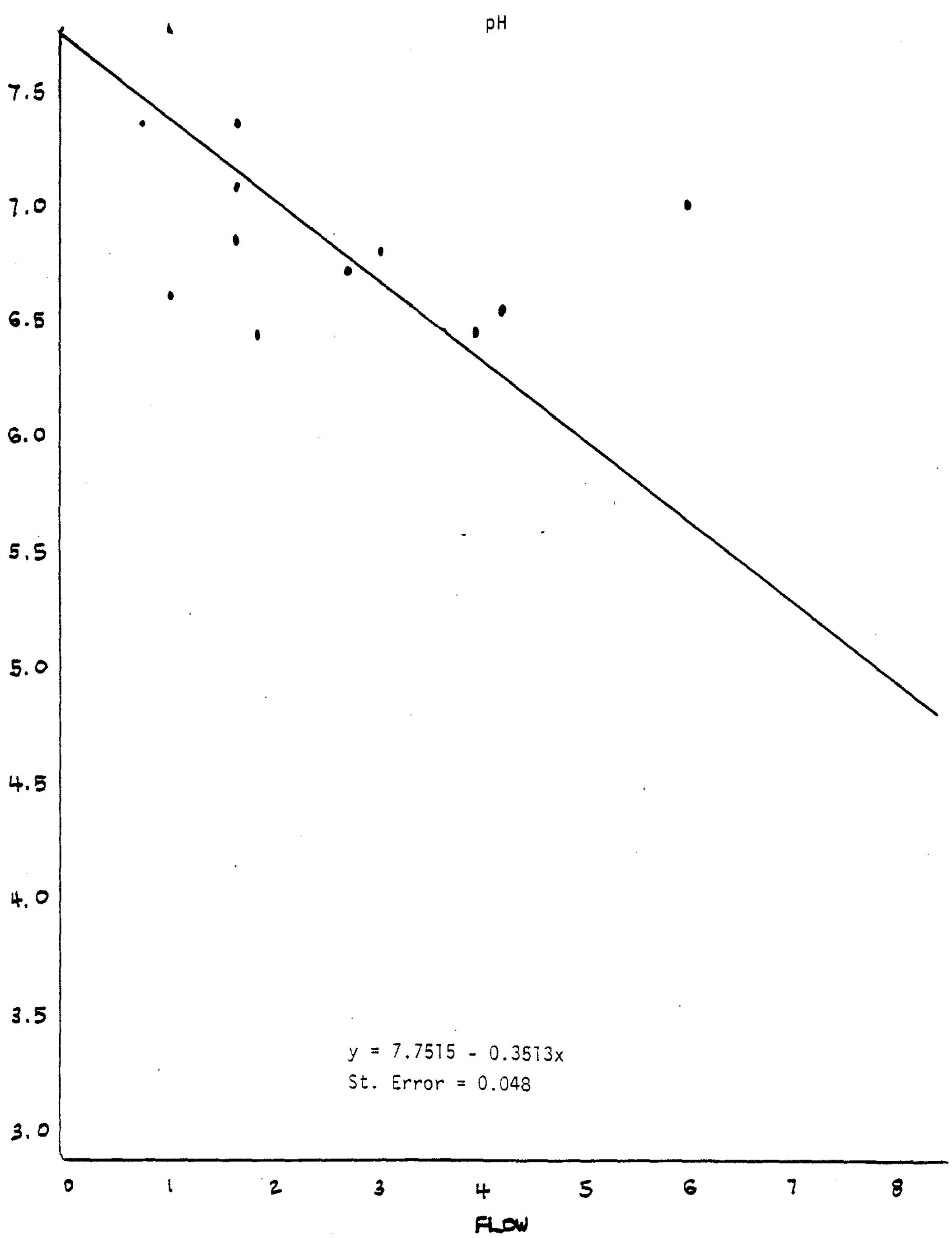

mg/l CaCO3
Group 1
Total Hardness
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
y = 104.905 - 10.0605x
St. Error = 1.576
0
1
2
3
4
5
6
7
8
9
10
11
12
FLOW

Group 1

Total Iron



Group 2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6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
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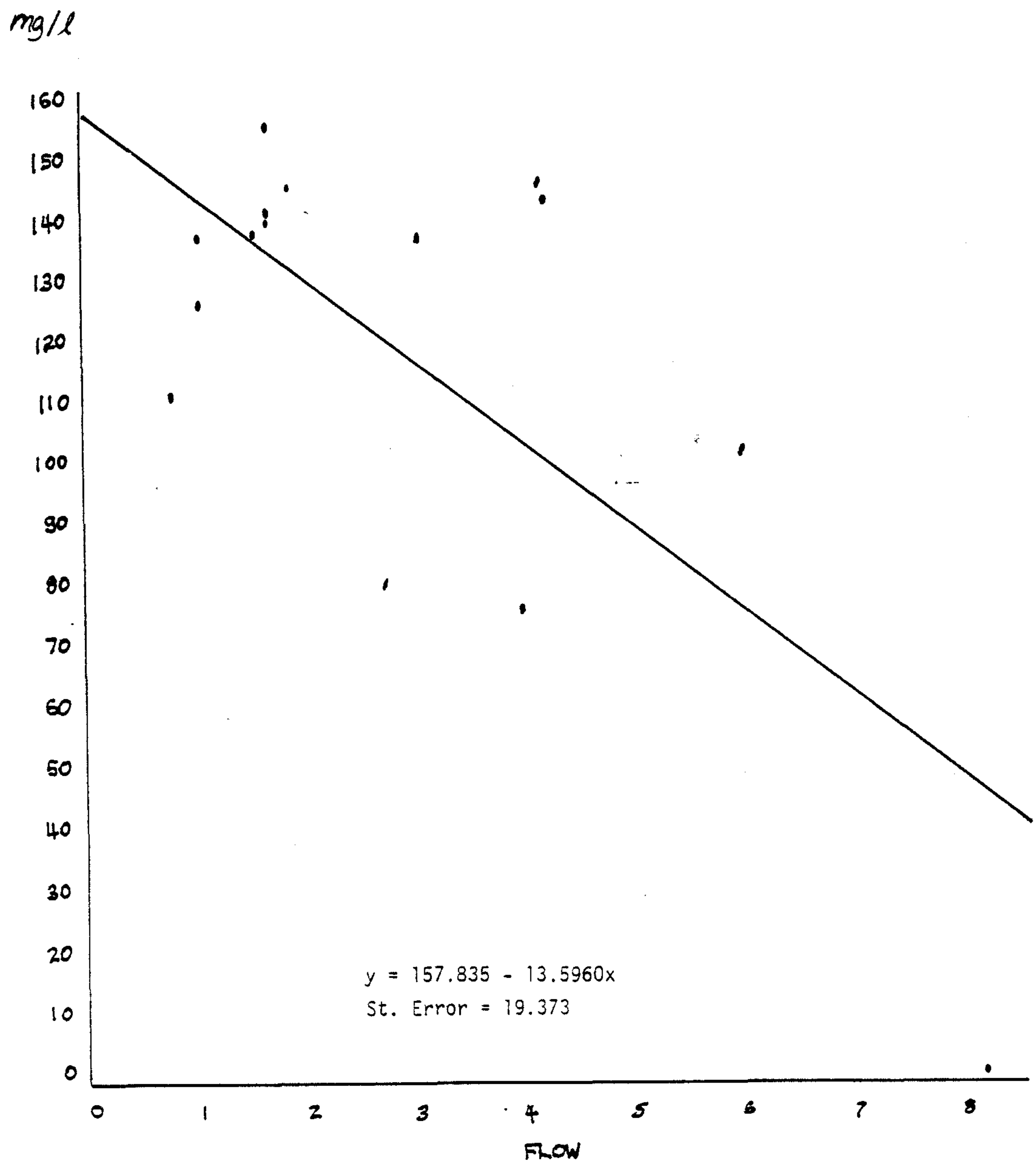
St. Error = 0.048
0
1
2
3
4
5
6
7
8
FLOW

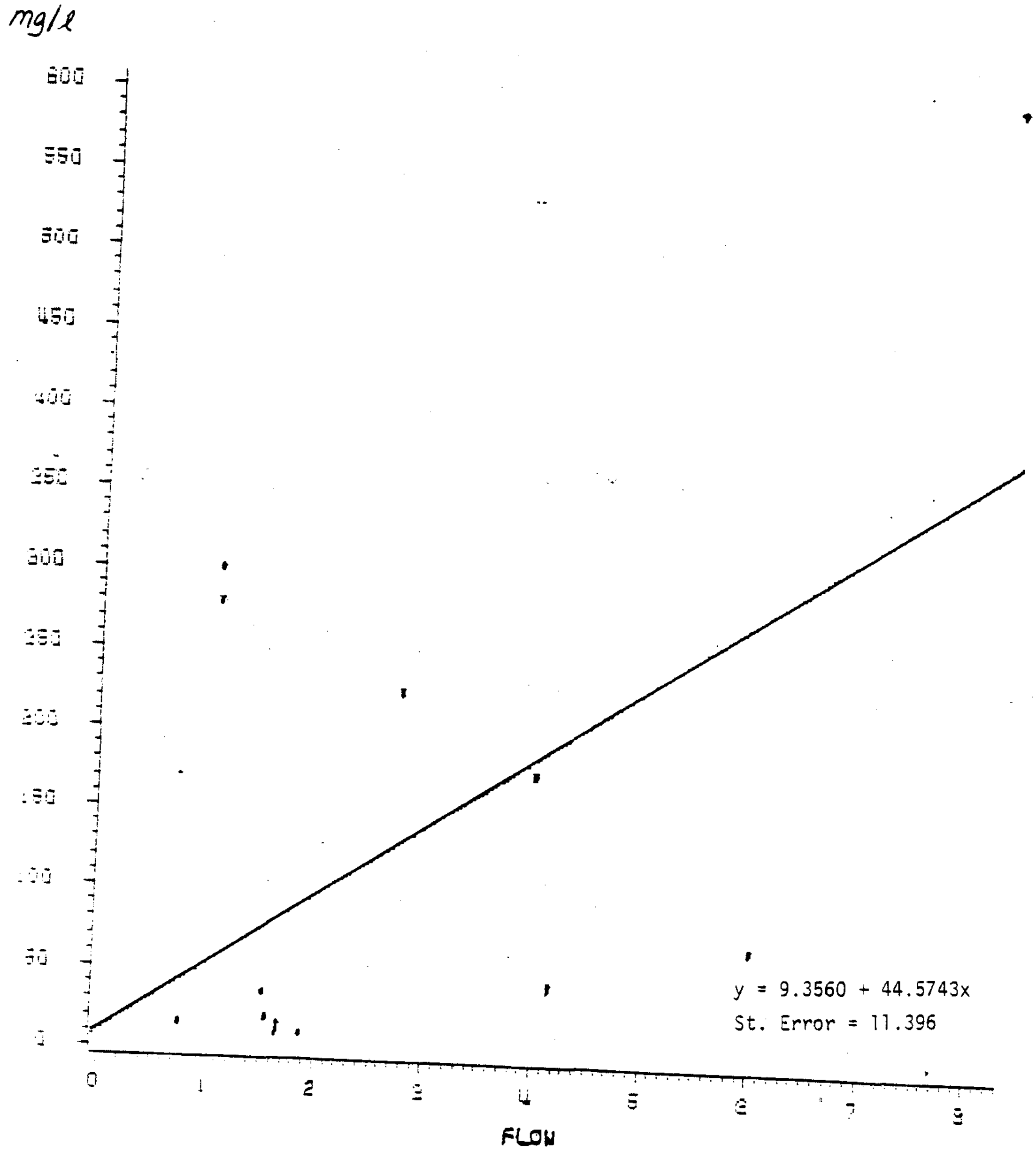
Group 2

Alkalinity



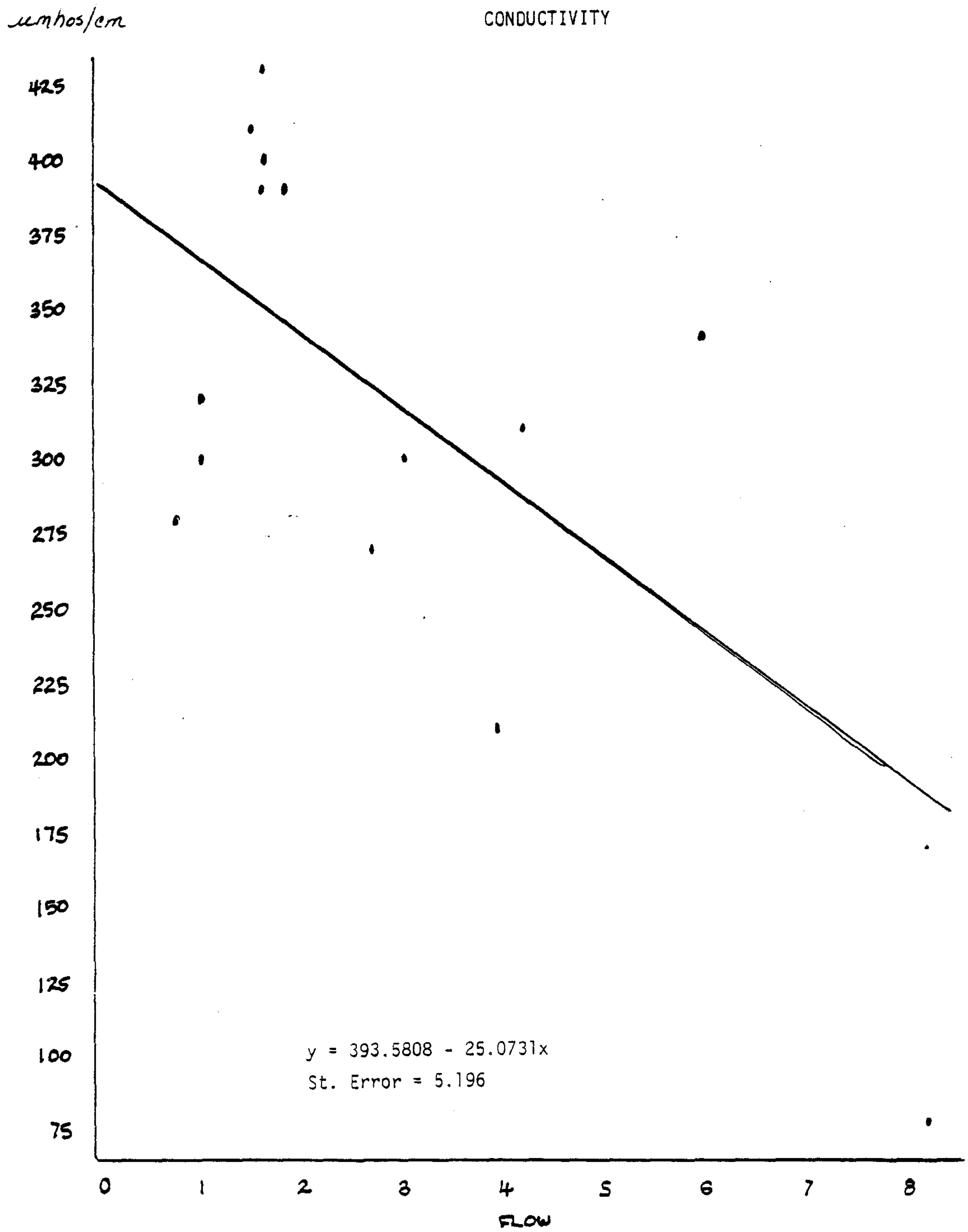
Group 2

COLOR



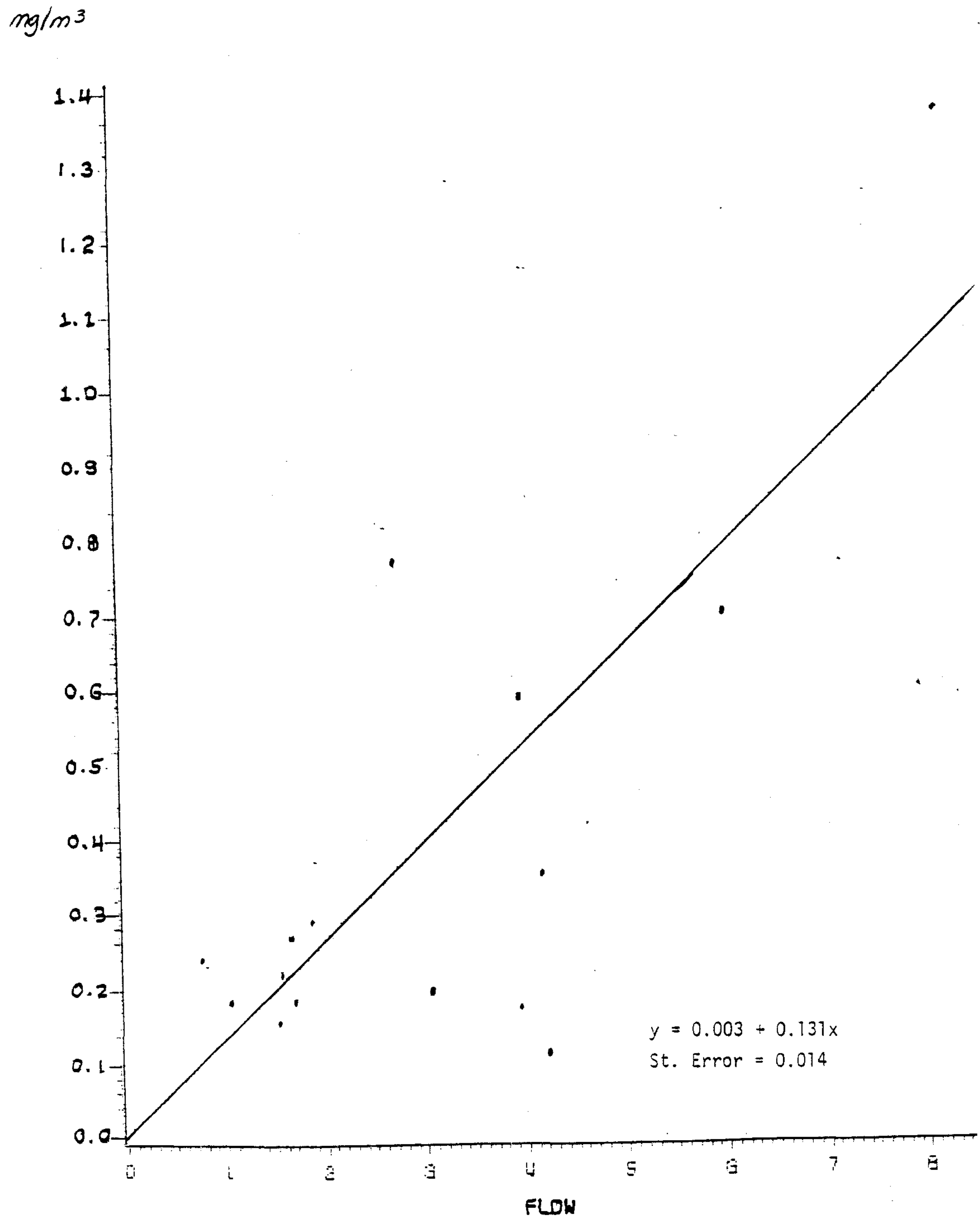
Group 2

CONDUCTIVITY

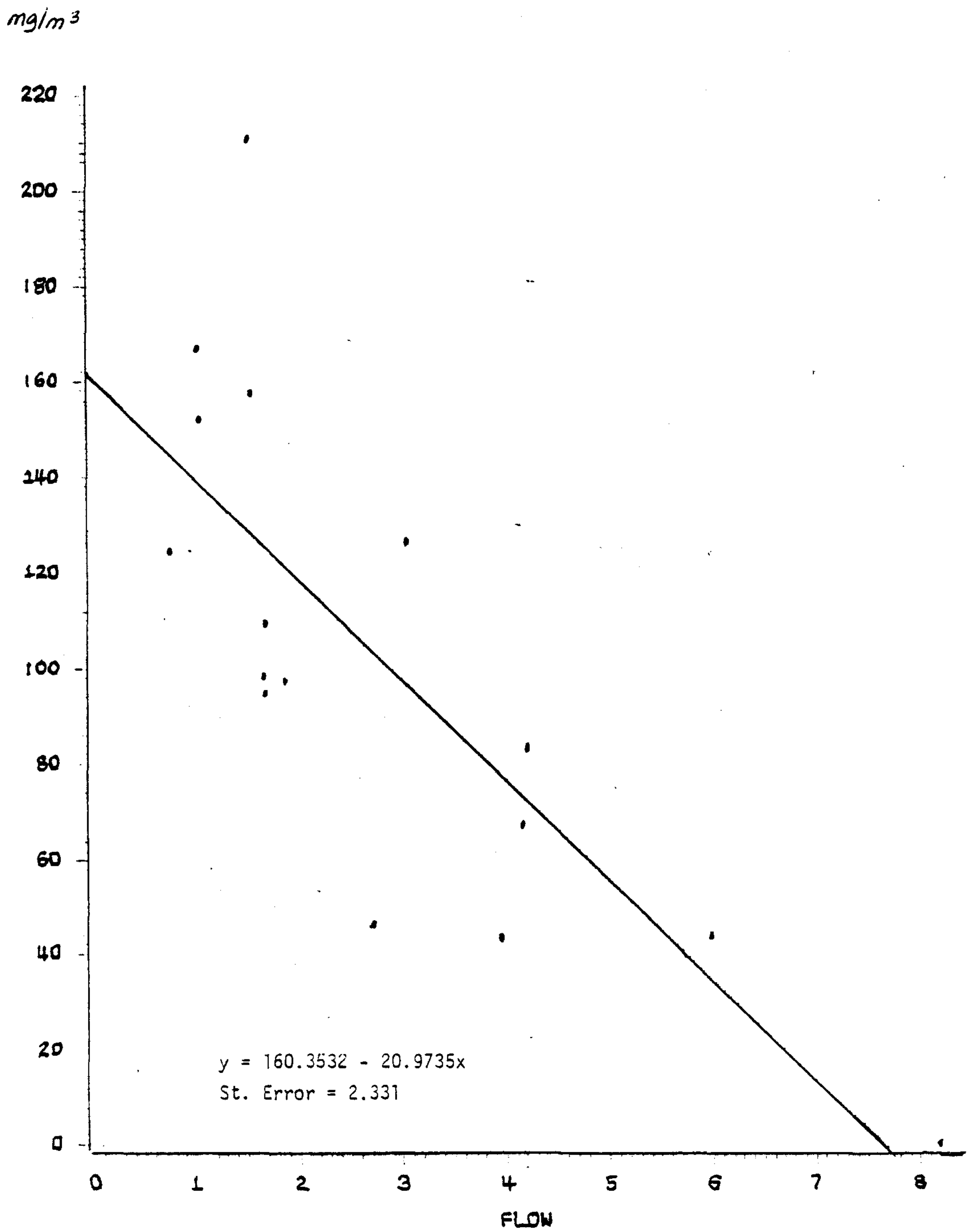


Group 2

NITROGEN

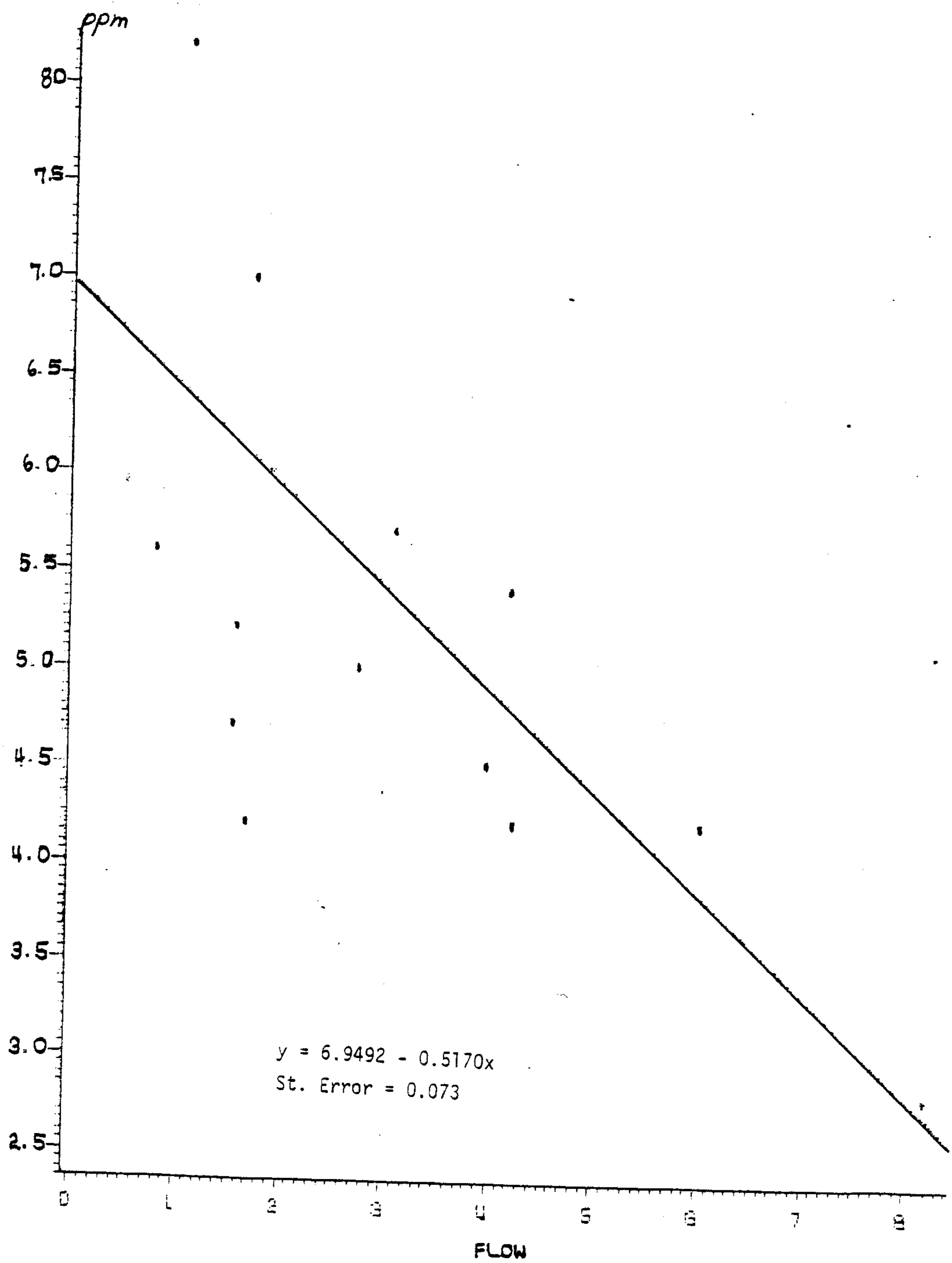


Group 2
Phosphorus



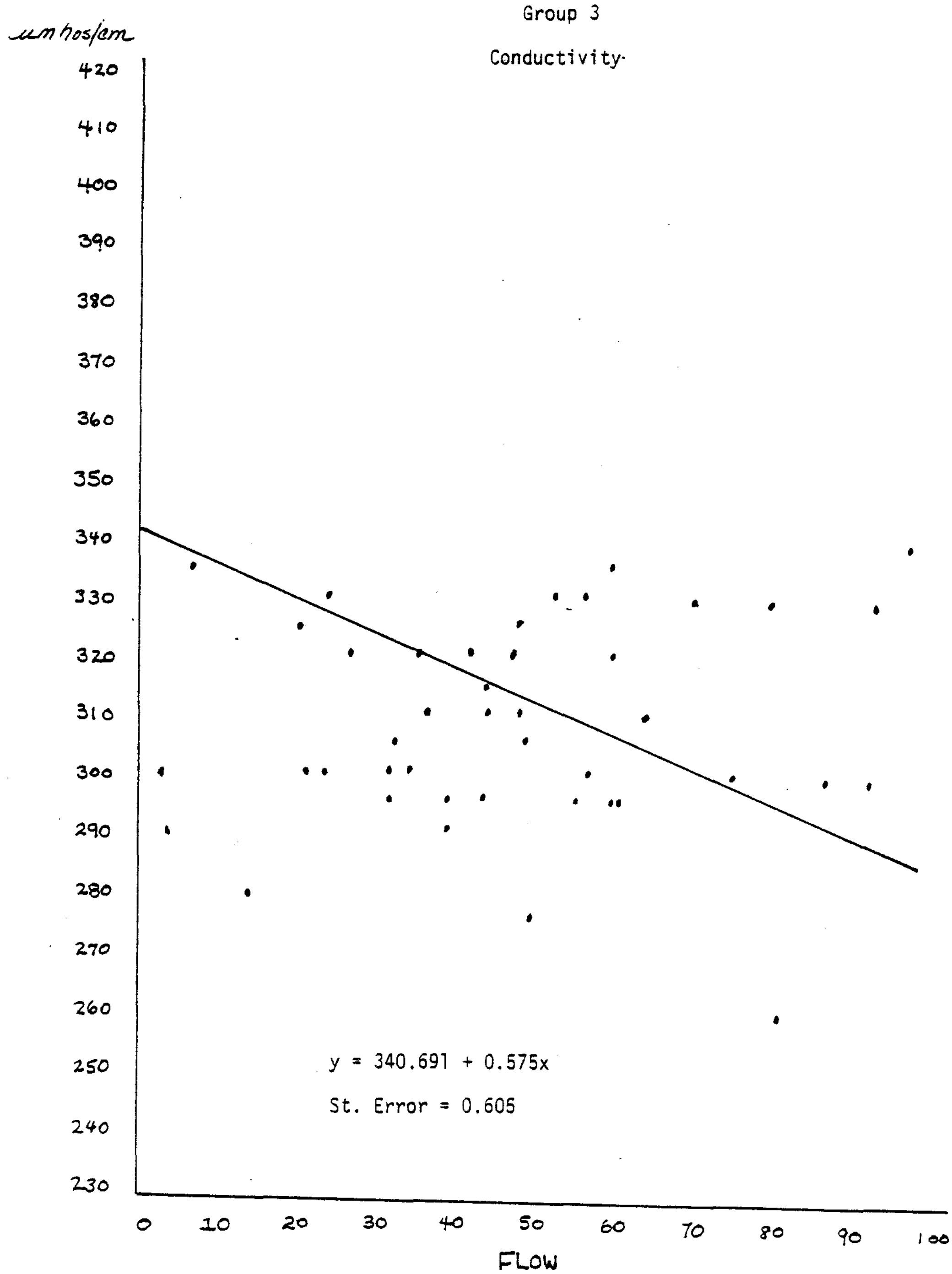
Group 2

DISSOLVED OXYGEN

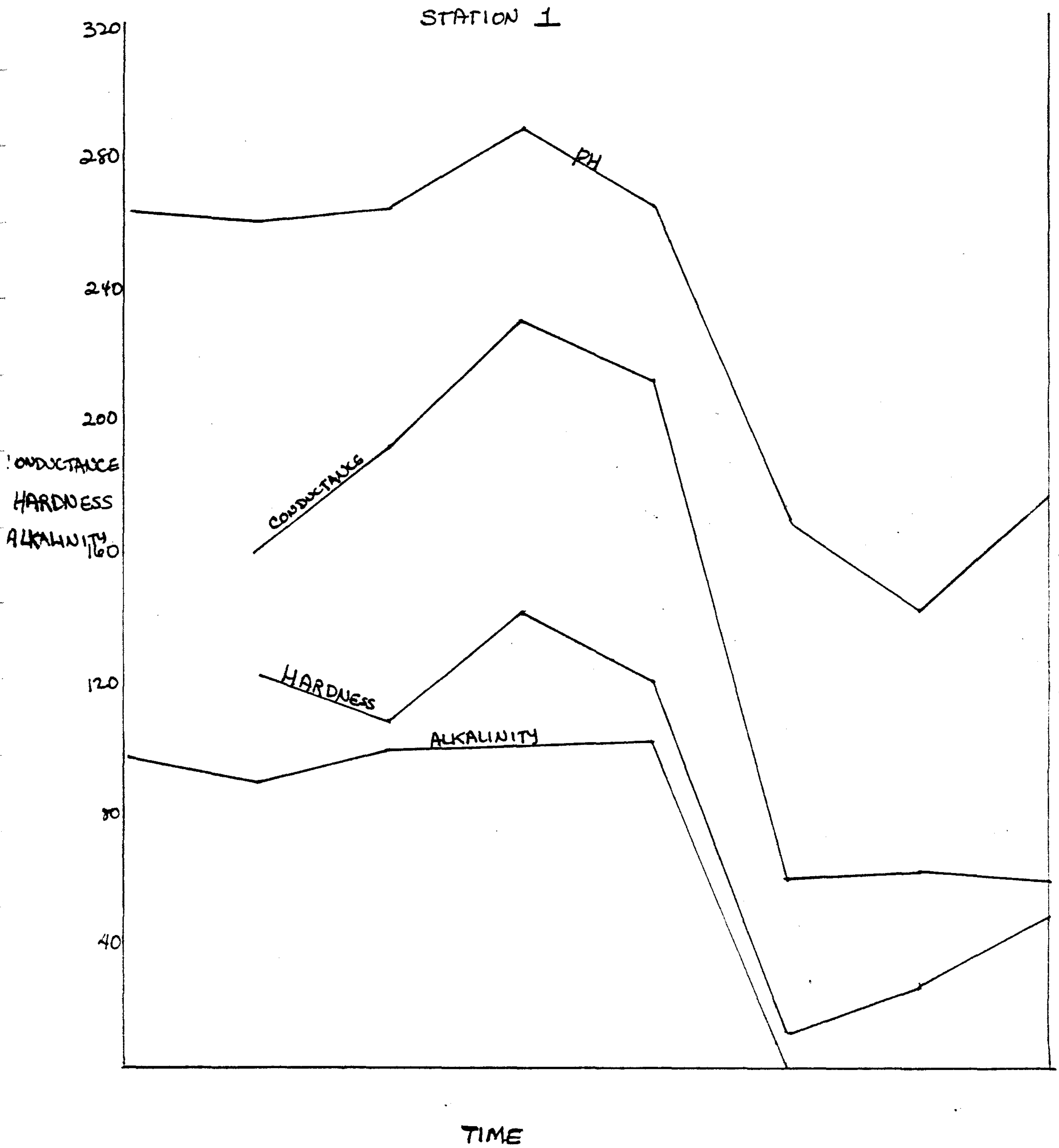


Group 3

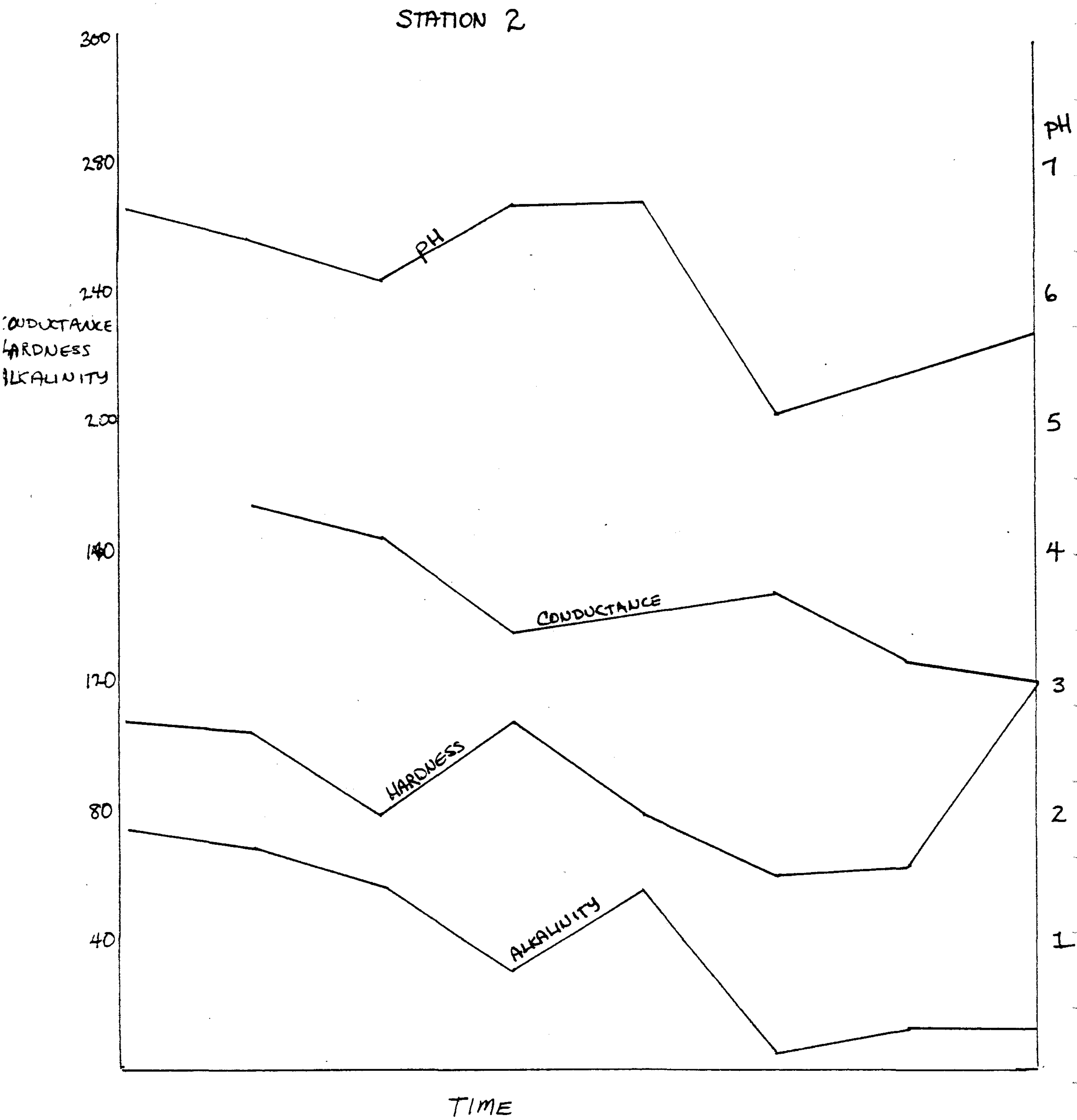
Conductivity



APPENDIX E



STATION 1
320
280
240
200
CONDUCTANCE
HARDNESS
ALKALINITY
160
120
80
40
pH
7
6
5
4
3
2
1
PH
CONDUCTANCE
HARDNESS
ALKALINITY
TIME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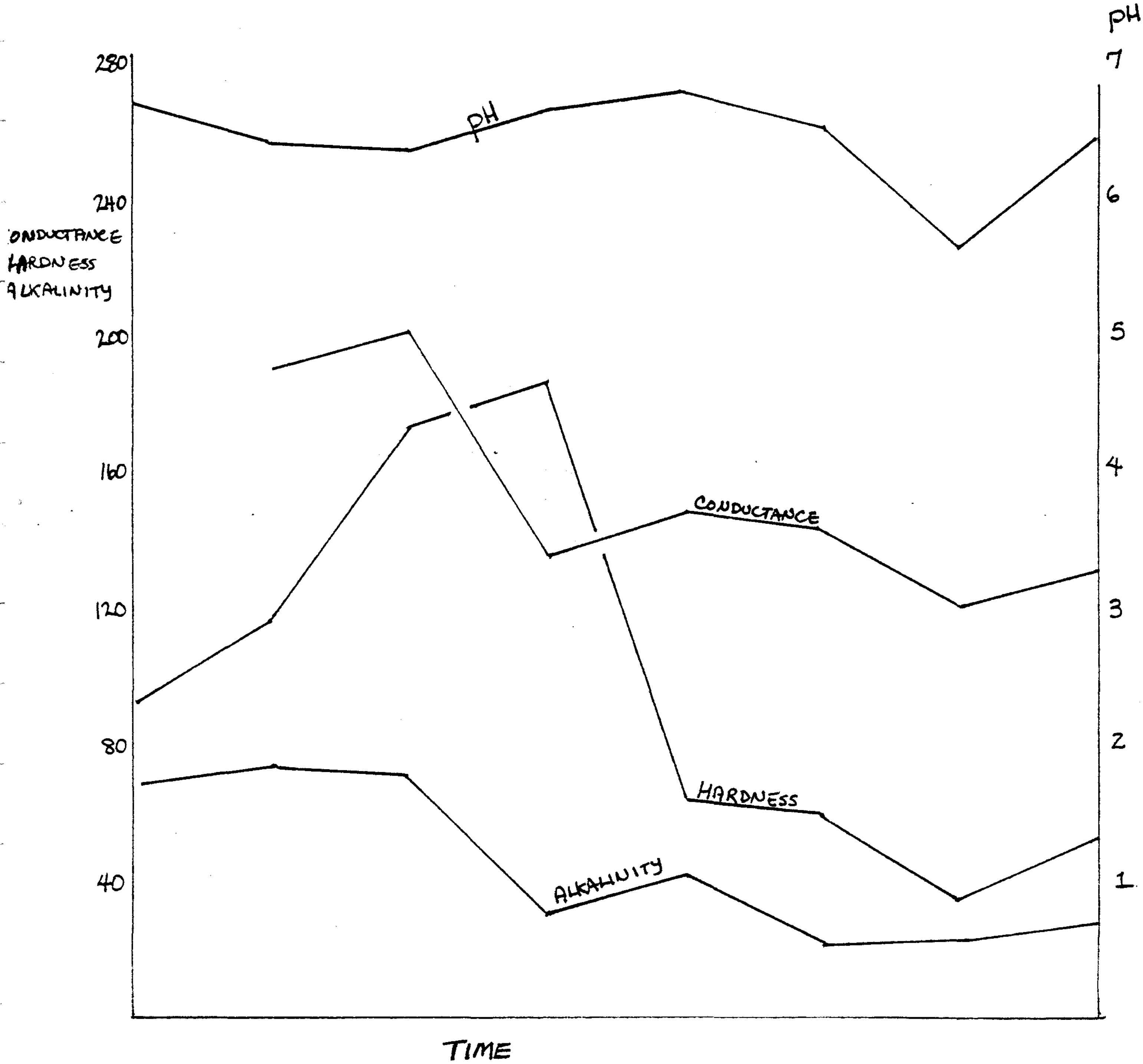
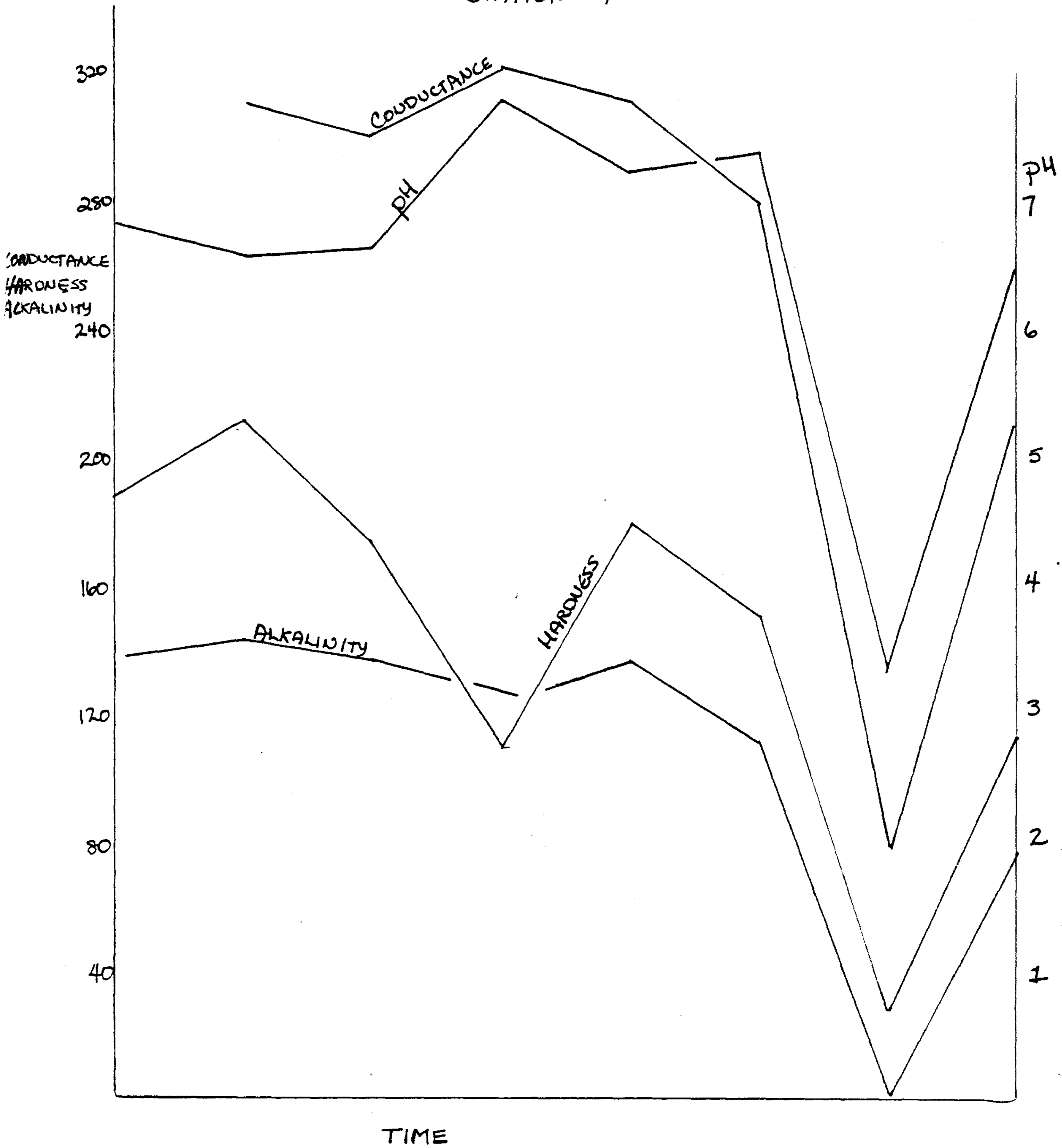
CONDUCTANCE
HARDNESS
ALKALINITY
200
140
120
80
40
pH
7
6
5
4
3
2
1
PH
CONDUCTANCE
HARDNESS
ALKALINITY
TIME

STATION 3

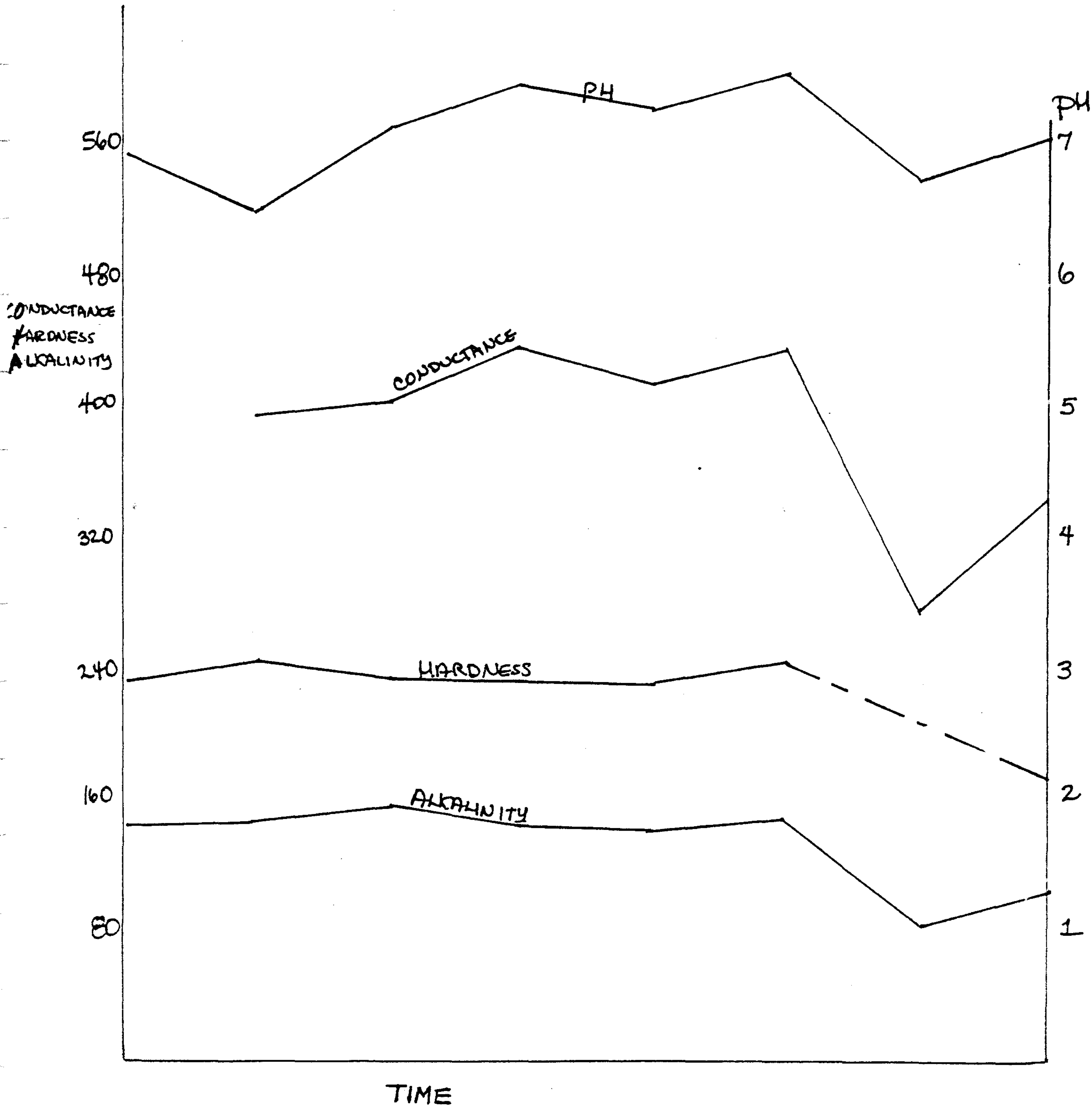

pH
280
240
200
160
120
80
40
7
6
5
4
3
2
1
CONDUCTANCE
HARDNESS
ALKALINITY
pH
CONDUCTANCE
HARDNESS
ALKALINITY
TIME

STATION 4

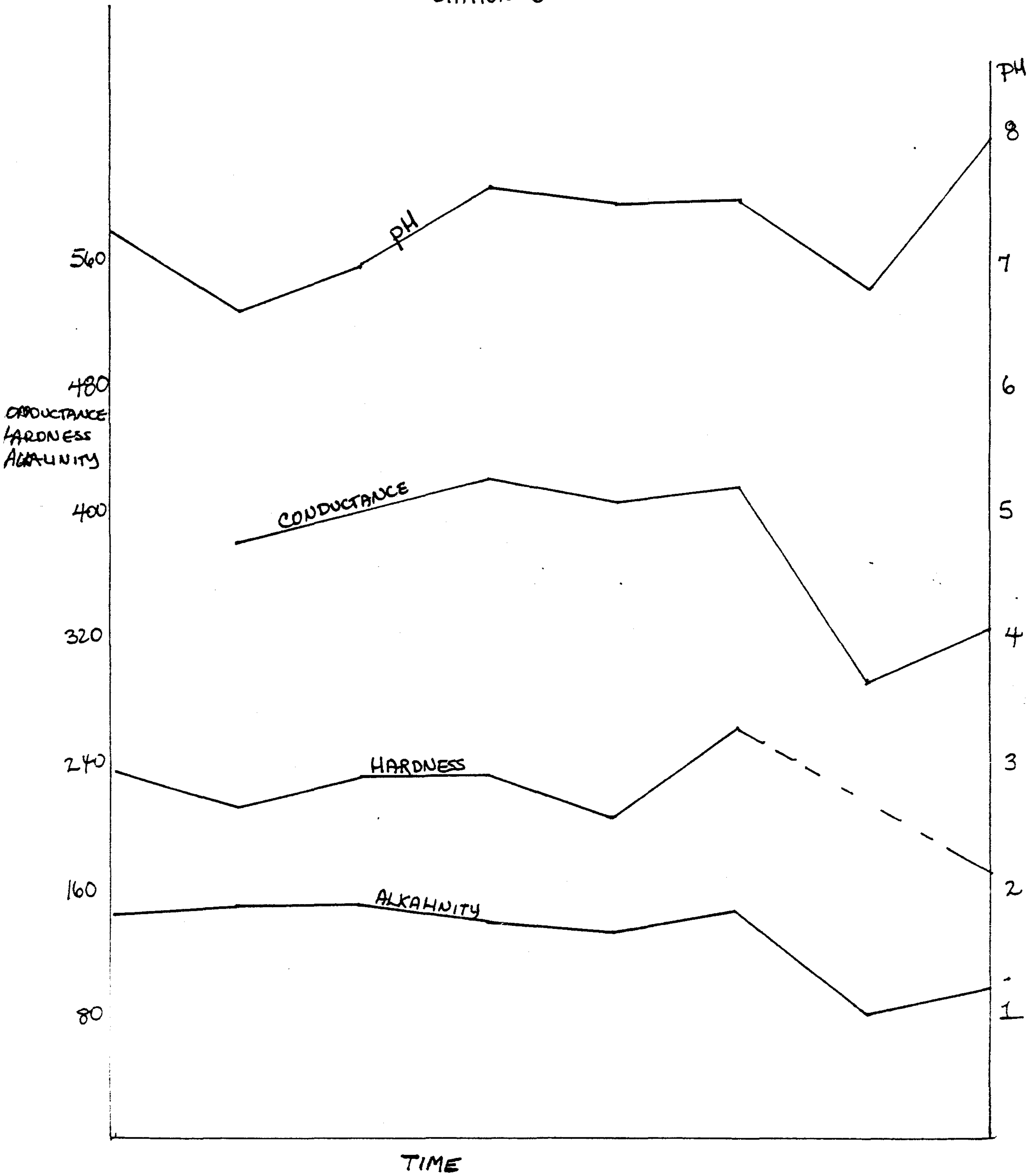


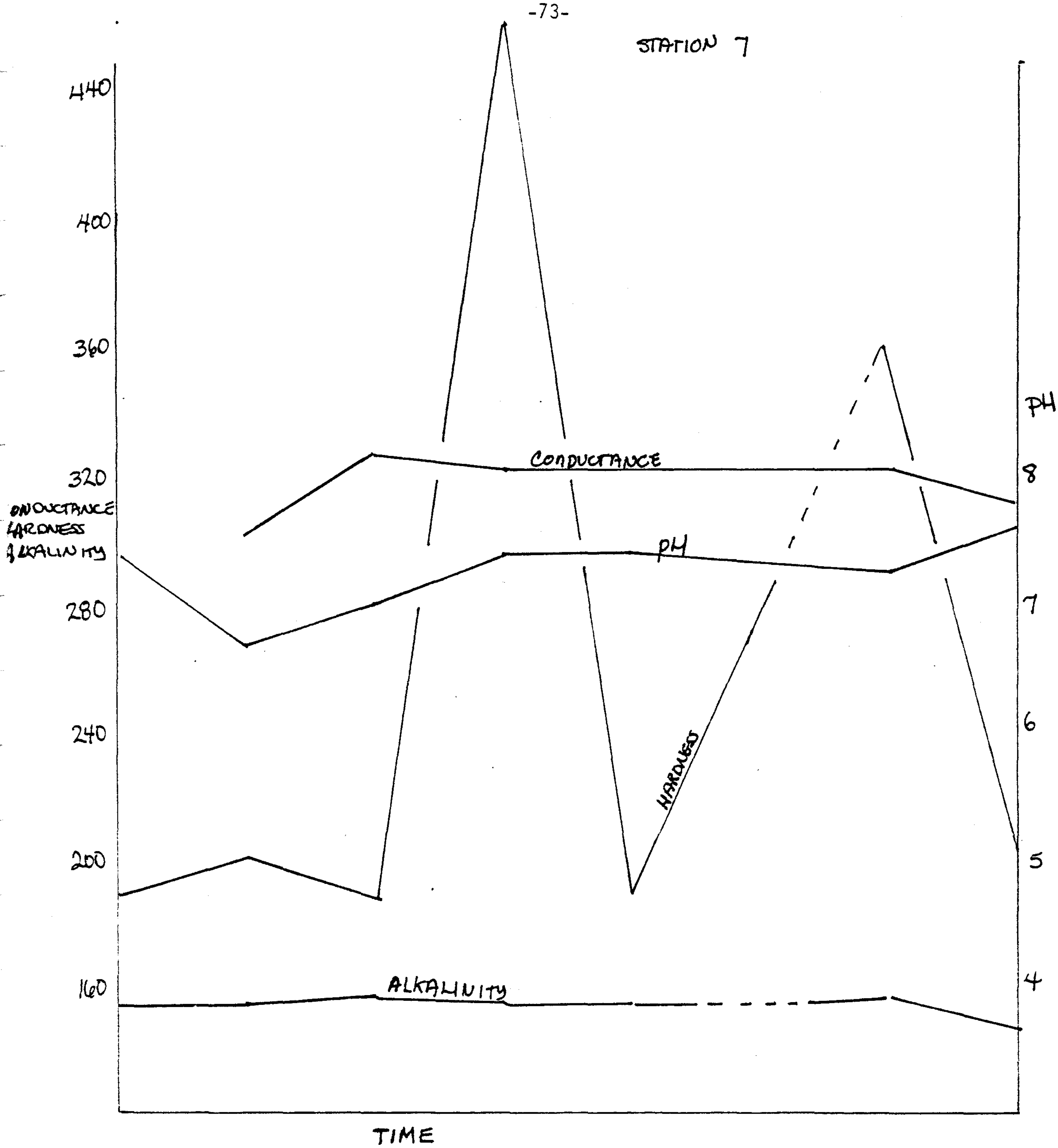
320
280
CONDUCTANCE
HARDNESS
ALKALINITY
240
200
160
120
80
40
CONDUCTANCE
pH
HARDNESS
ALKALINITY
pH
7
6
5
4
3
2
1
TIME

STATION 5


PH
560
480
400
320
240
160
80
CONDUCTANCE
HARDNESS
ALKALINITY
CONDUCTANCE
HARDNESS
ALKALINITY
7
6
5
4
3
2
1
TIME

STATION 6


PH
8
7
6
5
4
3
2
1
560
480
400
320
240
160
80
CONDUCTANCE
HARDNESS
ALKALINITY
pH
CONDUCTANCE
HARDNESS
ALKAHNITY
TIME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360
320
CONDUCTANCE
HARDNESS
& ALKALINITY
280
240
200
160
PH
8
7
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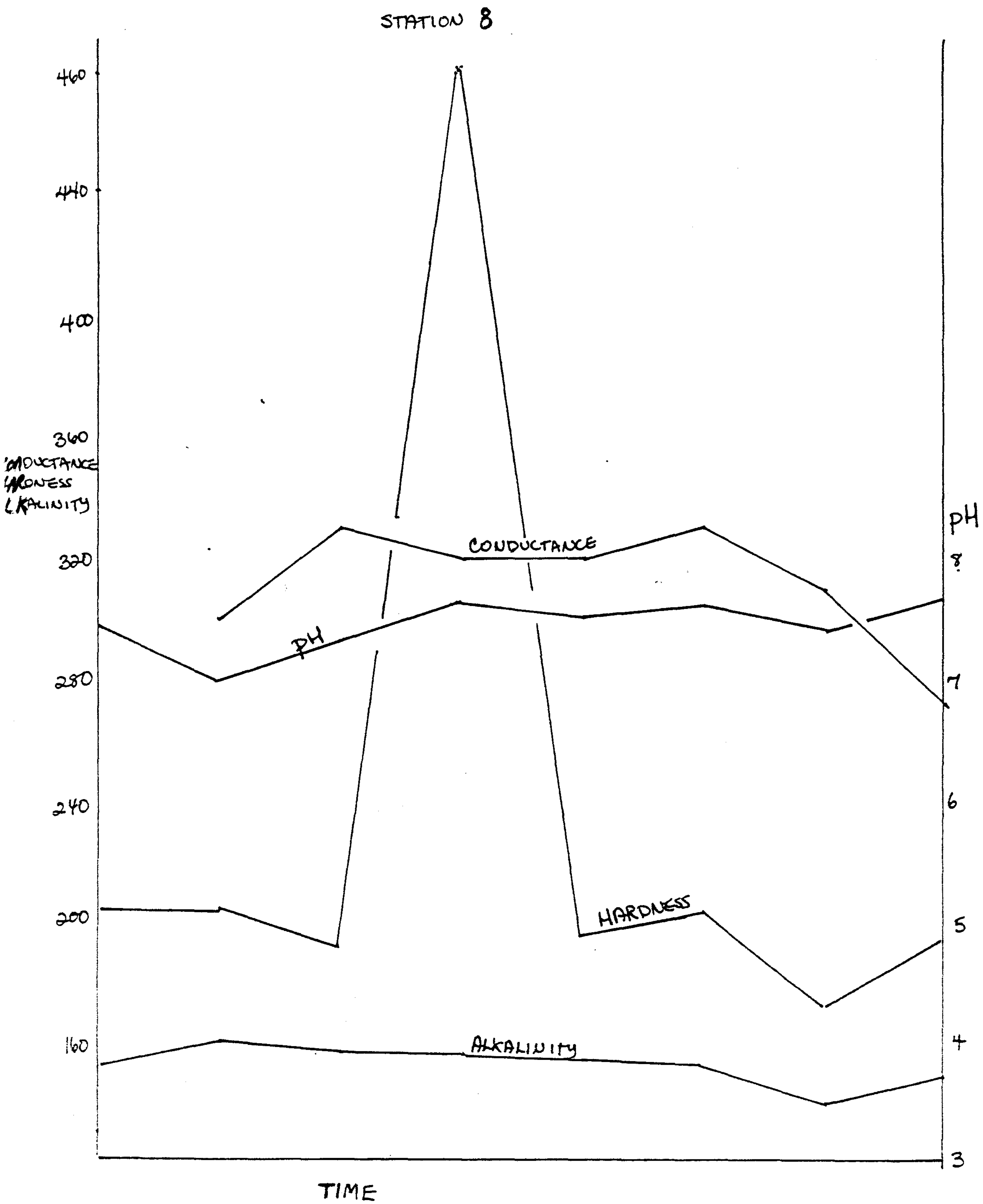
CONDUCTANCE
pH
HARDNESS
ALKALINITY
TIME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400
360
CONDUCTANCE
HARDNESS
& ALKALINITY
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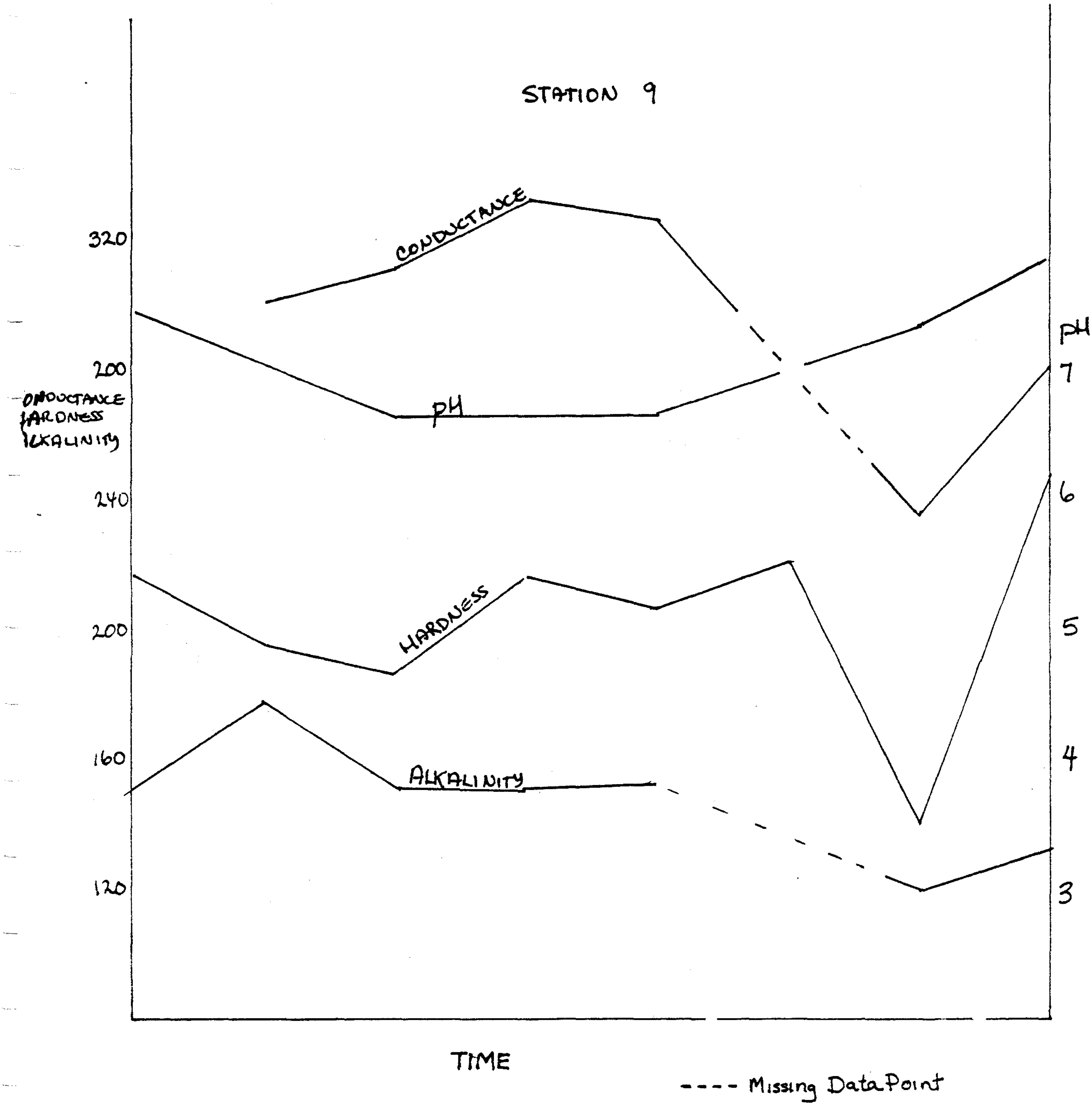
240
200
160
pH
8
7
6
5
4
3
CONDUCTANCE
PH
HARDNESS
ALKALINITY
TIME


STATION 9
CONDUCTANCE
pH
HARDNESS
ALKALINITY
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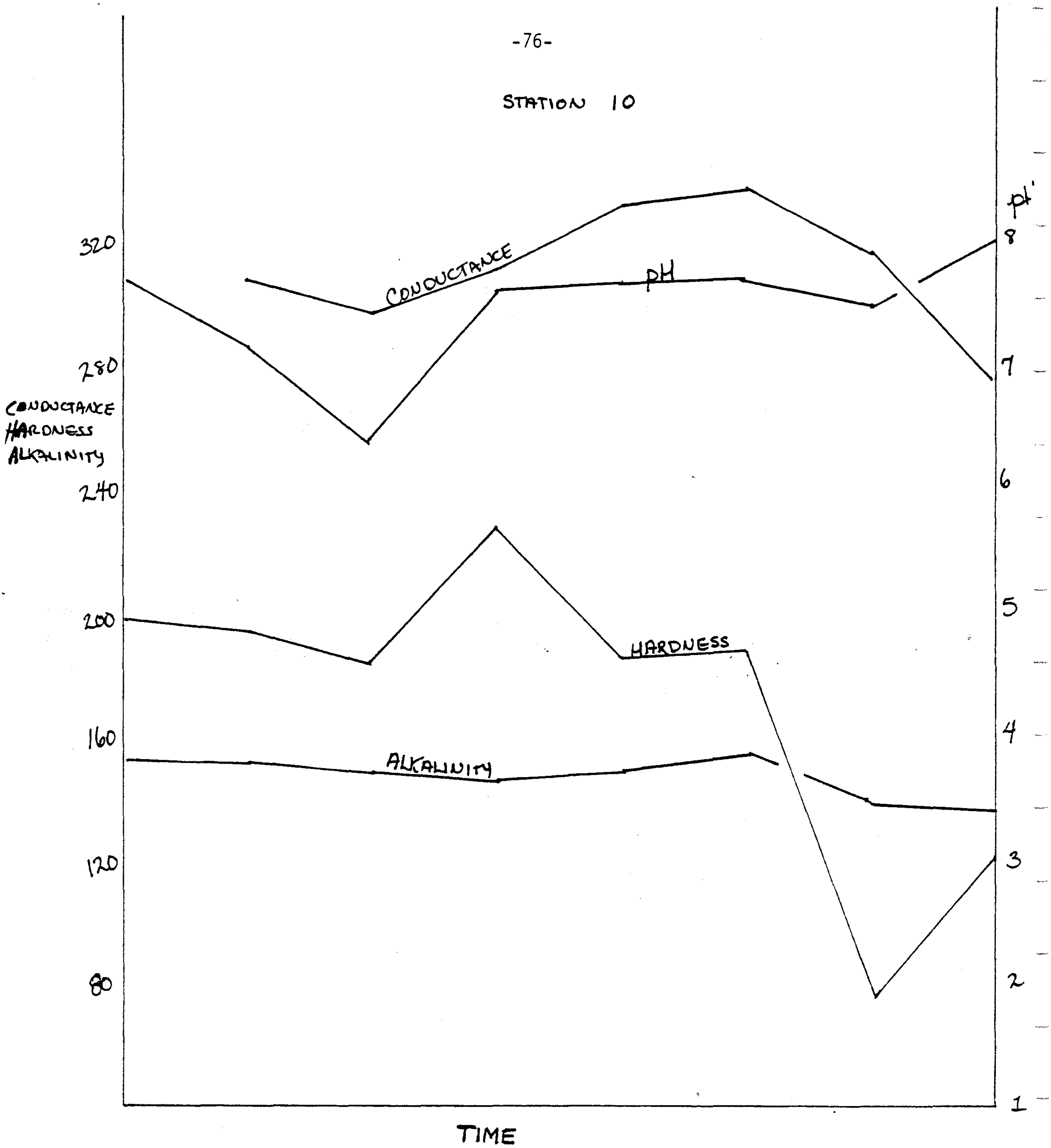
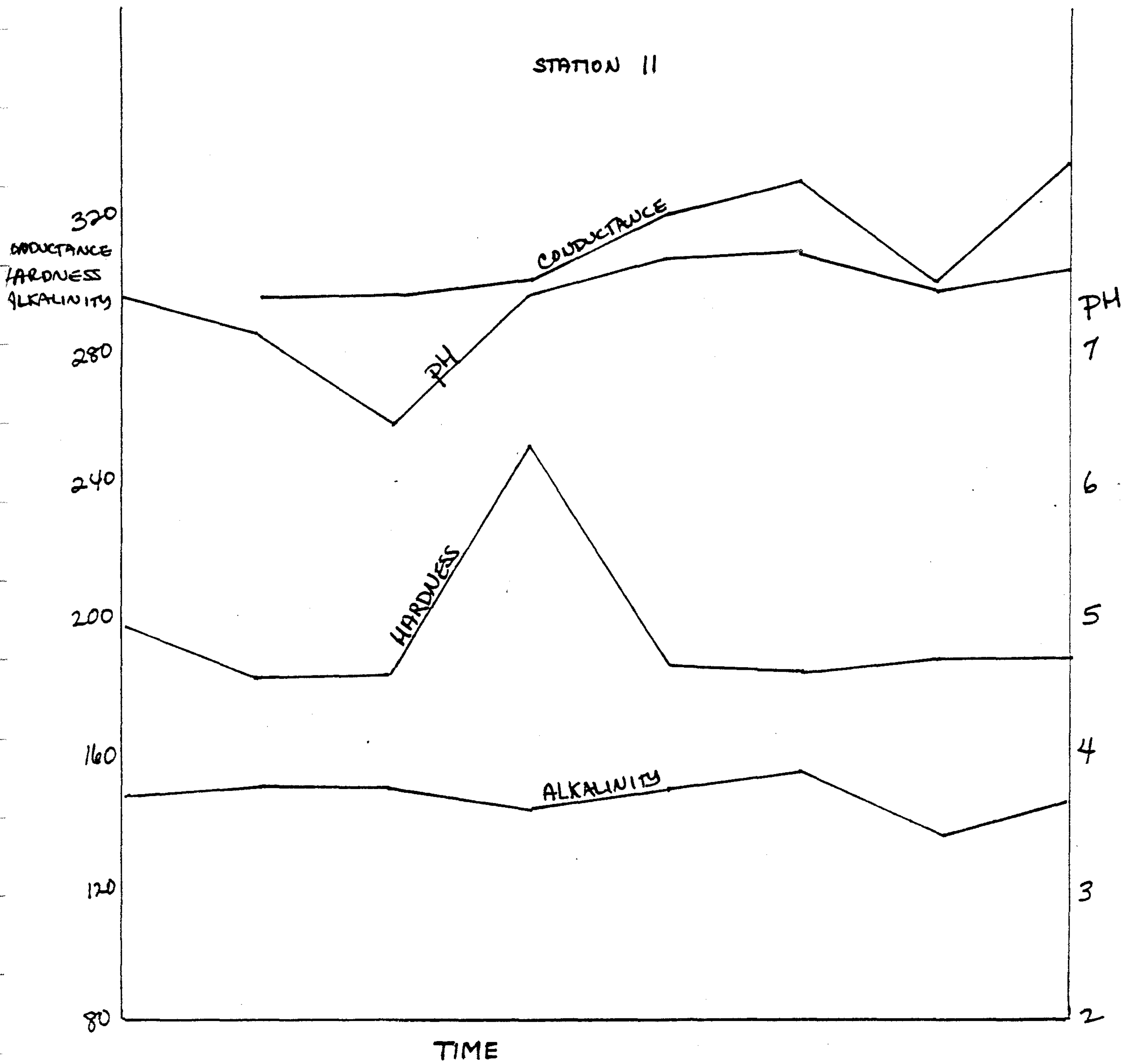
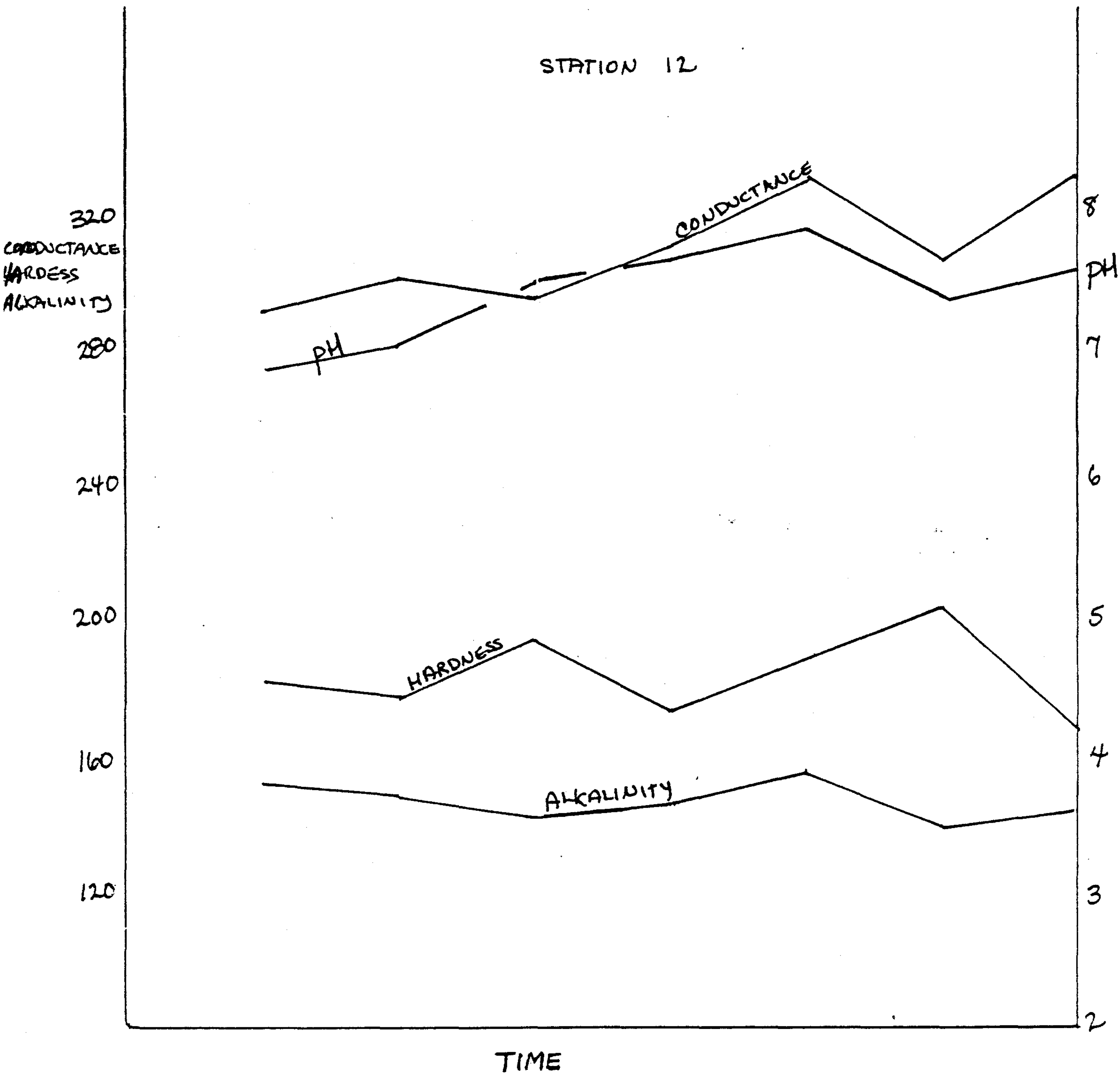
200
CONDUCTANCE
HARDNESS
ALKALINITY
240
200
160
120
pH
7
6
5
4
3
TIME
---- Missing Data Point

STATION 10


CONDUCTANCE
pH
HARDNESS
ALKALINITY
320
280
CONDUCTANCE
HARDNESS
ALKALINITY
240
200
160
120
80
pH
8
7
6
5
4
3
2
1
TIME


STATION 11
CONDUCTANCE
HARDNESS
ALKALINITY
320
280
240
200
160
120
80
PH
7
6
5
4
3
2
CONDUCTANCE
PH
HARDNESS
ALKALINITY
TIME


STATION 12
CONDUCTANCE
PH
HARDNESS
ALKALINITY
320
CONDUCTANCE
HARDESS
ALKALINITY
280
240
200
160
120
8
PH
7
6
5
4
3
2
TIME